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Jan. 15, 1950

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NUCLEAR SCIENCE ABSTRACTS

Vol. 4 No. 1

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ERRATA

In Abstract 3-500, Nuclear Science Abstracts 3, 126(1949) Aug. 15, substitute 26 μc and 260 μc (microcuries) for 26 mc and 260 mc (millicuries), respectively.

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NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

1 The Effect of BAL on Experimental Lead, Tungsten, Vanadium, Uranium, Copper and Copper-Arsenic Poisoning. Lehman M. Lusky, Herbert A. Braun, and Edwin P. Laug. J. Ind. Hyg. Toxicol. 31, 301-5(1949) Sept.

Young rabbits eight to ten weeks old were given single doses of a 1% solution of lead acetate (20-40 mg/kg) into the marginal ear vein; immediately after the lead administration, the treated animals were given an intravenous dose of a 3% aqueous solution of BAL (30 mg/kg), and 6 hr later, the same dose subcutaneously. Thereafter, BAL was given twice daily on the second, fourth, sixth, eighth, and tenth days in doses of 15 mg/kg; doses continued thereafter at longer intervals. In the tungsten and other experiments, adult rabbits were used, and they received single doses of 5-10% solutions of the metals followed by single doses of 30 mg/kg of BAL intramuscularly shortly thereafter (about 20 min). The results of the lead experiments indicate that the effect of BAL depends on the route of administration of the lead salt; a therapeutic effect for BAL was found only in those cases where the lead had been administered via the intravenous route. Even at high dose levels BAL did not protect the animals against toxic amounts of ammonium metavanadate or uranium nitrate administered subcutaneously; however, increased tolerance was observed in those rabbits which had received sodium tungstate, cupric sulfate, and cupric arsenite. 11 references.

2 Industrial Hygiene and Toxicology. Frank A. Patty, ed. New York, Interscience, 1949. 2 Vols., 1138p.

The various industrial health hazards in the form of toxic agents are discussed in a series of articles. The first volume is of a general nature, treating such topics as the mode of energy and action of toxic materials and the effects of radiant energy and radium. In the second volume the agents are considered specifically and a section on metallic toxins is included.

3 The Use of Beryllium in New York. John E. Silson, Lawrence P. Benjamin, and Samuel C. Wilson. Am. Ind. Hygiene Assoc. Quarterly 10, 45-8(1949) June.

The same article by the authors was published in Monthly Rev. of Division of Industrial Hygiene and Safety Standards (New York State Department of Labor) 28, 13-16(1949) Apr. It was listed in Nuclear Science Abstracts as Abstract No. 3-219.

BIOLOGY AND MEDICINE

4 A Comparison of the Absorption of Radioactive Sodium Iodide from Lard, Wool Fat and Petrolatum. Gilman N. Cyr, Donald M. Skauen, John E. Christian, and C. O. Lee, J. Am. Pharm. Assoc. 38, 615-18 (1949) Nov.

White rats of both sexes were anesthetized intraperitoneally with sodium pentobarbital, shorn of hair over a small area between the neck and the shoulder blades, and then treated with a solution prepared either from wool fat, petrolatum, or lard; sodium iodide labeled with I^{131} was added in order to trace the absorption rate of the iodide through the skin and in the presence of each of the compounds. Urine and droppings were collected, and after the animals were sacrificed their thyroid glands were excised and tested for radioactivity. Appropriate control animals were used to increase accuracy. It was determined that absorption of the sodium iodide through the skin was very small; the highest penetration amounted to 0.05% of the amount applied. Maximum absorption of the iodide from lard took place in about 30 hr; the absorption rate was greatest when ointments using white petrolatum were applied.

5 The Inhibition of the Cholinesterase Activity of Human Blood Plasma by Neutral Phosphate Esters. II. Studies with Hexa 1-C^{14}-ethyl Tetrapolyphosphate. Ralph W. Brauer and Rita L. Pessotti. Science 110, 395-6(1949) Oct 14.

In order to determine whether the interaction of plasma cholinesterase with phosphorus compounds such as hexaethyl tetrapolyphosphate (HETP) and others (compounds containing the grouping P-O-R and including a sterically strained configuration around the phosphorus atom or phosphorus atom participation in an acid anhydride) results in the formation of rather stable compounds involving the active groupings of the enzyme, experiments were performed, the results of which are described here. The experiments involved the use of C^{14}-labeled HETP; the procedure is described in detail. From the figures for the C^{14} uptake and for the specific activity of the sample of HETP employed, the molecular relationships were calculated. The data presented indicate the formation of a stable compound between plasma cholinesterase and a small fraction of the HETP required to inhibit the enzyme. About 82-84% of the C^{14} fixation was related to the enzyme inhibition, and the rest was accounted for by a much less specific reaction. A value of 3% for the purity of the enzyme preparation was also arrived at.

BIOLOGY AND MEDICINE

6 Instructions for Routine Measurements of Uptake and Excretion of Radioiodine. T. H. Oddie. Commonwealth X-ray and Radium Laboratory, Melbourne, Australia, Technical Communication No. 32, Mar. 3, 1949. 19p. (NP-991) (See also NSA 3-58).

Detailed procedures are presented for (a) the measurement of the uptake of I^{131} in situ in the thyroid gland by means of external GM counter observations and (b) the radiometric assay of the excreted I^{131} in the urine by the evaporated drop technique. These measurements will normally find most application in the diagnosis of thyroid disorders. They are also needed as a preliminary to the treatment of thyroid diseases with later larger therapeutic doses of radioiodine. In the latter case the preliminary tracer test enables a more accurate estimate to be made of the radiation dose that will be delivered.

7 Investigation with the Aid of C^{13}, of the Renewal of Dicarboxylic Aminoacids in the Liver. A. S. Konikova, V. N. Orekhovich, M. G. Kritsman, S. Ya. Davydova, A. S. Khokhlov, M. G. Kukavadze, B. V. Ottesen, M. I. Menshikov, and L. L. Gol'din. Doklady Akad. Nauk S.S.S.R. 65, 325-7(1949)(in Russian).

It has been generally accepted until recently that the synthesis of proteins is more intensive in tissues that are regenerating than in normal tissues. According to recent findings, this view is erroneous (Rittenberg et al, Currents in Biochemical Research, New York, 1946. p.272). The authors contributed new material by showing that the intensities of the formation of free dicarboxylic amino acids and of the renewal of carbon in normal and regenerating liver are equal. They introduced C^{13} into slices of liver tissue of a rat, in vitro, in the following experiments. Samples of tissue, normal or regenerating after operation, were incubated for several hours with a bicarbonate buffer containing $NaHC^{13}O_3$. After the precipitation of the proteins, dicarboxylic amino acids were isolated both from the precipitate and the filtrate (free acids); the carbon of the acids was converted into CO_2, in which C^{13} content was determined with a mass-spectrometer.

8 Iron Metabolism. Heme Synthesis in Vitro by Immature Erythrocytes. R. J. Walsh, E. D. Thomas, S. K. Chow, R. G. Fluharty, and C. A. Finch. Science 110, 396-8(1949) Oct. 14.

The results of studies on heme synthesis in vitro investigated with the Fe^{55} and Fe^{59} are presented. Blood samples from anemic and iron deficient patients and the bone marrow of rats and humans were used. It was determined that while blood containing less than 1% reticulocytes took up no measurable quantity of radioiron, the reverse was true with blood of high reticulocyte content; the radioactivity was localized in the immature cell population. The results also indicate that the physiological process of iron assimilation by the developing red cell is, first, the attachment of the iron to acceptors in the red cell stroma capable of removing iron from the serum and second, the synthesis of heme. It is also indicated that the reticulocytes are still capable of completing the process of hemoglobinization in the peripheral blood, in keeping with observations that tagged reticulocytes live a normal life span. The uptake of iron by normoblasts is much greater than with the reticulcytes; radioactive heme could also be demonstrated after incubation of radioiron with the marrow cells. It is concluded that the uptake of radioiron by reticulocytes may be used as an indicator of the rate of hemoglobin synthesis.

9 Isotopes and the New Alchemy. Thad P. Sears and Kenneth D. A. Allen. Rocky M. Med. J. 46, 931-6 (1949) Nov.

A brief resumé of the characteristics of isotopes is presented and some of the applications of isotopes to the practice of medicine are enumerated. P^{32} is mentioned in connection with blood flow and volume measurements, diagnosis of carcinoma, and treatment and study of bone conditions and metabolism; Sr^{89} is also used for the treatment of bone conditions; Na^{24} is discussed in connection with extracellular fluid measurements and in the diagnosis of peripheral vascular diseases; I^{131}, S^{35}, Fe^{59} and N^{15} are also mentioned. The authors conclude that the subject of biophysics will become of increasing importance to the physician.

10 Isotopic Tracers and Nuclear Radiations with Applications to Biology and Medicine. William E. Siri. New York, McGraw-Hill, 1949. 653p.

This work on the biological and medical applications of radioisotopes is divided into three principal sections. In Part I on isotopes and nuclear radiations, a general discussion is given of the properties of nuclei and the characteristics of nuclear particles and radiations, and fission. Methods and instruments are considered in Part II and the following are treated: counters, ionization chambers, mass spectrographs, standardization of radioactive samples, radioautography, tracer methods, dosimetry, obtaining thin films of radioactive elements by electrolysis, safe handling of radioactive materials, and the principles of the various particle accelerators. Part III is concerned with the biological and medical applications of isotopes and includes discussions of the major organic and mineral metabolite elements, trace elements essential to plants and animals, and isotopes in therapy and diagnosis. A 90-page bibliography is given which lists a group of general references as well as numerous references arranged according to element.

11 Preparation of Radioautographs of Tissues without Loss of Water-soluble P^{32}. Margaret W. Holt, Russell F. Cowing, and Shields Warren. Science 110, 328-9 (1949) Sept. 30.

The present investigation describes procedures which make it possible to use the radioautographic technique for a more complete study of the distribution of P^{32} in the tissues. The objective of the study was to devise simple methods to prepare tissue sections and mount them on photographic emulsions without encountering any appreciable loss or shift in the distribution of the radioactive element. A freezing and vacuum dehydration technique was devised and compared against other techniques. It was found that the method of

cutting and mounting the sections was important; contact with all solutions known to extract P^{32} was avoided as much as possible.

12 Retention of Radon by the Mouse. I. Experimental Determination of Biodecay and Energy Absorbed. Joanne Weikel Hollcroft and Egon Lorenz. Nucleonics 5, 63-71(1949) Sept.

This report describes the elimination of radon from mice following the administration of an aqueous radon solution; biodecay and the determination of the energy absorbed by the animal from the disintegration of the radon and its subsequent short-lived decay products are discussed. The radon used in the experiments was obtained by the α bombardment of $RaBr_2$; 75-80% of the total radon prepared was obtained in solution. Two methods were used to study the elimination of the radon: in the first, groups of mice were sacrificed by cervical dislocation 5, 10, 30, 60, 90, 120, 180, and 240 minutes after the radon administration, and were sealed quickly in glass tubes for subsequent measurement; in the second, after the administration of the radon, the live animal was placed in a small vessel, and by means of an air transfer system and activated charcoal collection bulbs, the radon was collected from the exhalations and measured at intervals. Preliminary studies were also made on the modes of administration of the radon; an intraperitoneal injection of 0.25 - 0.5 mc of radon was given and the amount in the mouse was determined 5, 10, 15, and 30 min later; the rate of elimination after oral administration was also studied. The results showed that the elimination rate, at least for the first hour, differed according to the route of administration used and was generally higher for the intravenous than for the other methods. The amount of fat present in the animal influenced the radon retention only after intraperitoneal injections.

13 Retention of Radon by the Mouse. II. Method of Estimating Biodecay from Experimental Data. Jerome Cornfield. Nucleonics 5, 68-75(1949) Oct.

This paper describes the method of estimating radon disintegration from the experimental data; the experimental data referred to is that which was presented by Hollcroft and Lorenz (Nucleonics 5, 63(1949)). A formula is derived for σD, the root mean square error, where D is the number of radon disintegrations. The author suggests how the error formula can be applied to the planning of experiments.

14 Some Applications of Nuclear Physics to Biology. W. Bladergroen. In: Prespectives Nouvelles dans la Chimie des Etres Vivants. Paris, Hermann and Co., 1949. p. 134-55. (in French).

This is one of eight articles by several authors, which are collected in a book of 198 pages under the general title "New Outlooks in the Chemistry of Living Beings." The present paper deals with the applications of radioisotopes in biochemistry, physiology, and therapy. Among the subjects reviewed are: the origin of phospholipids, the oxidation of the fatty acids, the chlorophyll function, the radio-phosphorus therapy of tumors, the radioiodine therapy of the diseases of the thyroid, the diagnosis of peripheral vascular troubles, the auto-radiography, and the use of neutrons in therapy.

BIOLOGY AND MEDICINE

15 A Study of the Absorption of Radioactive Sodium Iodide from a Variety of Ointment Bases. Donald M. Skauen, Gilman N. Cyr, John E. Christian, and C. O. Lee. J. Am. Pharm. Assoc. 38, 618-19(1949) Nov.

Sodium iodide labeled with I^{131} was applied in a 10% solution to the skin of rats and was used in combination with each of a variety of ointment bases for the purpose of determining the relative efficiency of the bases in permitting the absorption of the iodide ion; the technique used is the same as that described in a preceding paper (Cyr et al, J. Am. Pharm. Assoc. 38, 615(1949)). All of the rats so treated were sacrificed at the end of 30 hr and their thyroids were excised and tested for radioactivity. It was determined that hydrous wool fat appears to be more efficient than lard in permitting absorption of the iodide ion; 18 other bases exhibited an absorption efficiency comparable to that of lard. A difference in the type of emulsion does not seem to affect the absorption rate. Modification of this method, in order to permit more accurate relative measurements, is suggested by the authors.

16 Use of Radioactive Isotopes to Measure Intracellular Cation Concentrations in the Normal Dog. Marvin F. Levitt and Mario Gaudino. Am. J. Physiol. 159, 67-72(1949) Oct. 1.

In the experiments reported, extracellular space was measured in the dog with inulin, total body water was determined with deuterium oxide, and total sodium and potassium were determined by the in vivo dilution of Na^{24} and K^{42} These three measurements, made simultaneously, permitted the determination of the average intracellular cation concentration in the living, intact animal. Trained, normal, unanesthetized female dogs in a fasting state were used in these experiments; their urine was collected after inulin infusion; simultaneously, blood samples were taken to determine the concentrations of known amounts of D_2O, Na^{24} and K^{42} which were injected intravenously. It was shown that the average intracellular concentrations were 115 mEq/l. for potassium and 35 mEq/l. for sodium; the factors that determine the rate of disappearance of these two elements from plasma were discussed. 27 references.

17 Androgenesis, a Differentiator of Cytoplasmic Injury Induced by X-Rays in Habrobracon Eggs. Anna R. Whiting. Biol. Bull. 97, 210-20(1949) Oct. (See also NSA 2-704).

Wild type parasitic wasp females, Habrobracon juglandis, were x-rayed and mated to untreated males with one or more types recessive to the wild type. Two kinds of haploid males were produced, the gynogenetic with x-rayed chromosomes in x-rayed cytoplasm, and the androgenetic with untreated chromosomes in x-rayed cytoplasm. A simultaneous cross-firing technique was used to deliver the radiations at a kv of 182 with a filtering value of 0.2 mm

Cu at an intensity of 7210 r/min and a target distance of 9.5 cm. Doses were 50 - 144,200 r and were fractionated in some cases. It was found that at doses of 50 - 15,000 r death of the eggs was due to chromosomal injury, and was not reduced by fractionation or changes in intensity. Above 15,000 r, x-rays induced chromosomal injury which may have exerted a lethal effect on developing embryos; the lethal effect was reduced by fractionation of the dose. Gynogenetic males developed from the unfertilized eggs, androgenetic males from the fertilized eggs; the lethal dose for the gynogenetic males was about 2,400 r and about 54,000 r for the androgenetic males. It was determined that injured cytoplasm acts in a direct manner in killing the embryo and not indirectly through injury to the untreated chromosomes. The author concludes that the evidence supports the target theory of chromosomal injury. 23 references.

18 Biological Evaluation of 20 Million Volt Roentgen Rays. III. Recessive Sex-linked Lethals in Drosophila Melanogaster. Wilbur M. Luce, Henry Quastler, and Lester S. Skaggs. Am. J. Roentgenol. Radium Therapy 62, 555-8(1949) Oct.

The mutagenic effect of radiations from a 20 million volt source was investigated; the production of recessive sex-linked lethals in the sperm of Drosophila melanogaster males was the means of evaluating this effect. The results from conventional x-ray therapy machines were compared with those from the betatron, and it was determined that the betatron has a mutagenic effectiveness of about 70% that of the conventional machines; the values refer to the 25 r condenser thimble as the common standard.

19 The Calculation of the Tolerance Flux of Fast Neutrons. J. H. Tait. Atomic Energy Research Establishment Report AERE-T/R-273, Feb. 4, 1949. 13p.

The dose in roentgen is calculated at interior points of a semi infinite space consisting of human tissue, for the case when a monochromatic collimated beam of neutrons falls perpendicularly upon the free surface. The variation of the mean free path with energy is neglected, and with this approximation the biological effects can be shown to be proportional to the energy flux. This latter quantity is then determined as a function of the distance into the tissue using the Spherical Harmonics method P_7 approximation (AERE-T/R-231).

20 Circulating Antibodies and the Alarm Syndrome Brought on by X-irradiation. J. Lecomte and P. Fischer. Compt. rend. soc. biol. 143, 878-9(1949) June (in French).

Studies were carried out to determine whether the destruction of lymphocytes by x-irradiation is followed, in the sensitized rabbit, by an increase in the amount of circulating antibodies. The authors point out the importance of the lymphatic ganglia and the lymphocytes in the production and accumulation of antibodies; the injection of any antigen is followed swiftly by the appearances of antibodies in the lymphatic ganglia draining the region. Four rabbits (the serum of which had been rendered greatly precipitant with respect to horse serum) were irradiated with 200 r on their hind legs, after the withdrawal of a control sample of blood; samples were also taken 3 hr after, and 4 days after the irradiation. It was discovered that the destruction of the lymphocytes which accompanied the alarm syndrome caused by the administration of the x-rays was not followed by a simultaneous increase in the amount of circulating antibodies.

21 Cyanide and a Lethal Dose of X-rays. A. Herve and Z. M. Bacq. Compt. rend. soc. biol. 143, 881-3(1949) June (in French).

Mice of the black C-57 strain were irradiated by a single exposure to 500-600 r of x-radiations, delivered by a 230-kv machine with a 0.25 mm Cu filter, at a focal distance of 50 cm and at the rate of 30 r/min. The technique consisted in dividing the mice into three series: the first series received the x-radiation alone; the second series received an intraperitoneal injection of 0.1 mg of NaCN in an aqueous solution; the treatment for the third group consisted of giving the radiations immediately after the administration of the NaCN and while the animals were still in the state of prostration from the injection. The mortalities for the groups were recorded every 24 hr. The results indicate that the NaCN injection reduced the mortality of the mice, for the radiation dosage given, from 100% to 30%.

22 Early Reactions Following Roentgen Ray Epilations. I. Zugerman. Arch. Dermatol. and Syphilol. 60, 722-5(1949) Nov.

A report is presented concerning the radiation reactions in 312 children to x-ray dosages of 300 r delivered in the treatment of ringworm of the scalp; the report is divided into seven groups, depending on the quality of the rays used (60-100 kv with 0.5-1.4 mm Al filtration). The reactions were restlessness, nausea and vomiting, headache, loss of appetite or elevation of temperature; nervous children exhibited a greater frequency of the reactions than non-nervous children. The results indicate that the voltage in these cases should not exceed 80 kv, and low filtration of not more than a half layer of 0.5 mm Al should be used. A quiet, cooperative child lessens the reaction severity and frequency.

23 Effects of Beta Rays on Central Nervous Tissues. Berry Campbell and Rosalind Novick. Proc. Soc. Exptl. Biol. Med. 72, 34-8(1949) Oct.

The gross morphological changes evoked in the neutrons and glial cells of the nervous system of cats by high doses of ionizing β radiations are described here. The use of local irradiation by means of a radon applicator was made in order to study a sharp gradient of tissue reaction in the cerebral cortex. Trephining of the calvarium over the parietal region of the cerebral cortex was performed under anesthesia, and the region was exposed to the radiations for 5-32 min, the calculated activity of the applicators being 30-78 mc; the dura was then returned to place, and after the animal was killed, the irradiated region was dissected

out fresh or after perfusion with formalin. Restricted lesions were found, complete necrosis being observed in some cases only a few mm from normal tissue. Nerve cells showed two types of destruction: lysis of the cytoplasmic structures and degeneration into a small aggregation of basophilic granules; and, chromophilic alteration of the cells, the pyramidal cells of layers 2, 3, and 5 evidencing special susceptibility. The astrocytes were the most susceptible of the cerebral cortex cells, undergoing lysis in the middle of the lesions; the mesoglial cells, oligodendroglia and microglia were highly resistant.

24 Experimental Investigations Concerning Roentgen Effects and Chemical Effects on Plant Mitosis. K. Hohl. Stuttgart, Georg Thieme Verlag, 1949. 87p. 30 pictures and tables (in German).

This monograph presents the results of investigations concerning the chemical and physical-chemical factors which involve and influence plant mitosis. The specific effects of some agents in the production of plant anomalies are discussed; effective groups are outlined and described.

25 Fluorescein as an Adjunct in the Treatment of Radionecrotic ulcers. Bromley S. Freeman. Surg. Gynecol. Obstet. 89, 566-9(1949) Nov.

A technique is described which involves the use of fluorescein in marking areas of necrotic degeneration, such as those caused by radio-necrosis. A 10 cc quantity of 5% fluorescein and 5% bicarbonate is injected intravenously and the fluorescein is made visible by a beam of long wave ultraviolet radiation, wherever the rays can penetrate. Upon reaching a capillary, the dye diffuses through the wall into the interstitial spaces; dead tissue cells do not stain even if the blood supply to the area is preserved. The radionecrotic lesion is observed for three gross changes: complete absence of fluorescence—a completely devitalized region; partial or weak fluorescence—partial devitalization; and, normal fluorescence—normal vascularity. Surgical excision of the completely devitalized area and as much of the partially devitalized area as is possible is immediately performed; deeply devitalized areas are investigated and excised in stages on the operating table. The authors conclude that fluorescein enables the surgeon to determine the actual extent, levels and degree of vascularization of the area and thus reduces the incidence of failure in the treatment of radionecrotic and other lesions. 10 references.

26 Hematologic Studies in Hiroshima and a Control City Two Years After the Atomic Bombing. Fred M. Snell, James V. Neel, and K. Ishibashi. Arch. Internal Med. 84, 569-604(1949) Oct.

Nine hundred and twenty-four relatively heavily irradiated subjects were examined in Hiroshima to determine their peripheral hematological condition 20-33 months after irradiation; they were chosen on the basis of degree of epilation. The results of erythrocyte and leukocyte counts, differential blood counts, hemoglobin concentrations, hematocrit readings, plasma readings, and reticulocyte counts were compared with those of a normal group of subjects from another city. It was observed that: the erythrocyte counts, hemoglobin concentrations and hematocrit readings were slightly, but significantly, depressed for the irradiation subjects; the irradiation subjects showed a slight relative depression of lymphocytes and a slight elevation of eosinophils; plasma protein values possibly were higher in the Hiroshima subjects; and, there was a significantly greater variability in the results in Hiroshima than in the normal group, which cannot be attributed to a differential response on the part of any particular age or sex group. The individual subjects who absorbed greater amounts of radiation tended to show the most pronounced depression in the erythrocyte and lymphocyte counts and the greatest elevation in the eosinophil counts. The authors advise against attributing the slight differences observed here entirely to atomic radiation.

27 On the Sensitization of Tissues to X-Rays. E. E. Umanskiĭ, B. M. Varshavskiĭ, and V. P. Kudokotsev. Doklady Akad. Nauk S.S.S.R. 65, 581-3(1949)(in Russian).

Numerous attempts have been made to increase the sensitivity of organs or tumors to x-rays by introducing into the tissues heavy metals, iodine, or dyes. However, no convenient biological process has as yet been found to serve as a standard for the comparison of the sentitizing properties of various substances. For that purpose the authors propose the regeneration of amputated limbs of caudate amphibia, which, as is known, can be completely arrested by x-rays. They experimented on adult Triturus cristatus, using as sensitizers fluorescein, neutral red, and Congo red. The first of the three dyes was injected into the limb (1% alkaline solution, four days), the other two were added to the water (0.1%) into which the animals were placed for five days. The amputation took place seven days after the irradiation. The table shows the percentage of cases of regeneration:

Doses in r	3,000	2,000	1,000
Control	11	100	100
Fluorescein	0	0	25
Neutral red	0	12	100
Congo red	0	100	100

Congo red has no sensitizing properties. Fluorescein is the best sensitizer employed: even with 1,000 r, in the 75% cases in which the regeneration was not entirely suppressed, it was considerably weakened.

28 On "Poteosthor" and Its Components. I. First Report on the Effect of Thorium X on Tubercle Bacilli (Tbb) in Vitro. Ludwig Popp and Hermann Egelhaaf. Zentr. Bakt. Parasitenk. 154, 49-56(1949) May 15 (in German).

In vitro experiments testing the effects of Th X (Ra^{224}) on tubercle bacilli (Tbb) of the human and the bird (typus gallinaceus) strains are reported. It was found that when a

strength of 125-166 esu. of Th X/cc solution was placed in contact with 100,000-1,000,000 of the bird type of Tbb or 1,000,000-10,000,000 of the human type, growth inhibition after 24 hr was sufficiently established to ensure safe inoculation. In growth-stunting experiments made with Sauton cultures, it was found that a total inhibition of human Tbb occurred after contact with 10 esu. of Th X/cc; tuberculosis could no longer be obtained by inoculation with the bacteria. It is concluded that the effect of Th X on the destruction of Tbb is purely radioactive.

29 Program and Abstracts of Seminar Papers Presented at the Marine Biological Laboratory, Summer of 1949. Biol. Bull. 97, 221-71(1949) Oct.

Among the papers presented at the Seminar at the Marine Biological Laboratory during the summer of 1949 were the following: X-ray mutations and fecundity of Mormoniella, P.W. Whiting and Marion E. Kayhart; The uptake and loss of K^{42} in the unfertilized and fertilized eggs of Strongylocentrotus purpuratus and Arbacia punctulata, Edward L. Chambers; The release of radioactive Ca^{45} from muscle during stimulation, Arthur A. Woodward, Jr.

30 Rapid Modification of the Oligodendroglia after the Application of X-rays to the Hind Legs of the Rabbit. M. A. Gerebtzoff and A. Herve. Compt. rend. soc. biol. 143, 880-1(1949) June (in French).

A study was made of the central and peripheral nervous tissue of rabbits which had been irradiated on the hind legs with 2,000 r at one exposure. The only histologic modification observed was a swelling of the qligodendroglia; the swelling was observable 3 hr after the irradiation and lasted up to 21 hr later. It is concluded that the oligodendrocytes are elements which are extremely sensitive and reactive to a small stimulation, such as that produced by the x-rays.

31 Suprarenal Cortex Reactions Following the Administration of X-Rays from a Distance in the Rabbit. E. Nizet, C. Heusghem, and A. Herve. Compt. rend. soc. biol. 143, 876-7(1949) June (in French).

The results of an investigation to determine the similarity between x-radiation reactions and the characteristic reactions following stress or emotional stimuli are presented. The rabbits were separated into nine groups of two animals each, and the control animal from each group was tested over a period of 21 days, in order to determine the amount of excretion of 17 ketosteroids. The hind legs of rabbits in eight of the groups were then irradiated with doses of 2,000 r delivered by a 200 kv machine at a focal distance of 40 cm through a filtration of 0.5 mm Al and at the rate of 100 r/min. The animals from the irradiated groups were then sacrificed after 3, 6, 24, and 48 hr and 3, 4, 5, and 45 days, respectively. The animals in the remaining untreated group were sacrificed after 3 and 24 hr, respectively. The results show that the x-radiation produced an increased loss of lipids from the suprarenal cortex; the loss occurred much more rapidly than during periods of emotional stress and persisted for a shorter time. The authors explain this

divergence on the basis of the small degree of stimulation which is caused by the radiation and the short duration of the treatment.

32 The Time Factor in Lethal Effects of Total Roentgen Irradiation in Triton. V. V. Brunst and E. A. Sheremetieva-Brunst. Am. J. Roentgenol. Radium Therapy 62, 550-4(1949) Oct. (See also NSA 3-1509).

The results of an investigation to determine variations in the effect on adult tritons (Triton cristatus, Amphiboa, Urodela) with variations in the length of time used to distribute a definite total dosage of radiations are presented. The radiations were delivered by a 120-kv source with a filtration of 3 mm Al, and at a variable target distance; in the first series of experiments, all groups were given 3,000 r total body irradiation, fractionated in daily doses of 150-3,000 r; in the second series all animals received a total of 2,000 r, delivered in daily doses of 100-2,000 r. The results indicate that the lethal effect of total body irradiation on the adult animals is not dependent on the distribution of the dosage in time; the triton apparently accumulates even small doses during a long period of protracted or fractionated treatment. 21 references.

33 X-Radiation of Eggs of Rana Pipiens at Various Maturation Stages. Grace Saunders Rollason. Biol. Bull. 97, 169-86(1949) Oct.

Eggs of Rana pipiens in the germinal vesicle stage (ovarian eggs), metaphase of the second maturation division (uterine eggs) and during completion of the second maturation division (eggs twenty minutes after fertilization) were irradiated with doses of roentgen units ranging from 100-41,600 r. The irradiation was carried out by means of two Coolidge-type water-cooled tubes at 180 kv, through filters of 2 mm Cu and 1 mm Al; no filtration was used with the highest dosage given, 41,600 r. Counts were made of cleaved eggs, gastrulae, neurulae, hatched embryos, and normal tadpoles. The jelly surrounding the eggs was apparently unaffected except on the ovarian eggs at the highest irradiation doses (25,600 r and 41,600 r); damage at these doses may have been an indirect effect of the x-rays on the oviduct. The cleavage rate and pattern were not affected; the percentage of cleavage was very much lowered, however, by the irradiation. The lower doses of x-rays had relatively little effect on the ovarian eggs; the uterine eggs were more sensitive to x-radiation than were the ovarian eggs, while the fertilized eggs were by far the most sensitive of the three groups tested; when a dose of 1000 r was administered to the fertilized eggs, only 9.6% of the animals gastrulated, 1.4% of these showed evidence of neurulation and none hatched; a dose of 41,600 r inactivated the uterine eggs, while at this latter dosage, although only a small percentage of the ovarian eggs cleaved, of those that cleaved, 87.5% gastrulated, 62.5% neurulated, and 10.71% hatched. The types of abnormalities produced by irradiation of the eggs are similar to those resulting from irradiation of the sperm of the same species. A delay of 24 hr between irradiation and fertilization of the uterine eggs, to simulate the required delay for the ovarian eggs, appeared to have no effect; there seemed

to be no recovery from the effects of the x-radiation. There was no difference in the effectiveness of the different x-ray intensities used in this work as long as the toal roentgen exposure remained the same. 43 references.

34 X-ray Tolerance of Living Cells as Measured by Cytoplasmic Streaming. Charles J. Bishop, Victor D. McLaughlin, and Donald F. Tapley. Can. J. Research 27, 262-8(1949) Oct.

An investigation was undertaken to determine the immediate effects of x-radiations on living, non-dividing cells, using the rate of cytoplasmic streaming as an indication of cell vitality. The observations were carried out on the stamen hairs and pollen tubes of Tradescantia paludosa, a diploid species, and on Tradescantia virginiana, a tetraploid species. In each experiment cultures were checked for rates of streaming and then were subjected to large, uninterrupted dosages of 250,000-450,000 r for the stamen hairs and 100,000-125,000 r for the pollen tubes; subsequent dosages of 25,000 were given until cytoplasmic streaming ceased. The radiations were administered by a standard Coolidge x-ray tube having a filtration of 1 mm Al and operated at 140 kv with a beam intensity of 1200 r/min. In both diploid and tetraploid stamen hairs, 700,000 r was required to stop all streaming, while in the pollen tubes of diploid and tetraploid plants, streaming was stopped by 250,000 r and 200,000 r, respectively; greater sensitivity was found with an increased initial dosage of continuous irradiation. 12 references.

35 The Atomic Bomb and Hazardous Radiation. Donald H. Hale. Armed Forces Chem. J. 3, No. 5, 18-19, 38, 40(1949).

The health hazards from radiation produced by the explosion of an atomic bomb are discussed.

36 Atomic Defense—A Constructive Approach. Richard D. Wolfe. Military Engr. 41, 417-20(1949) Nov.-Dec.

The effects of the explosion of an atomic bomb are discussed and means of minimizing or reducing the effects are considered. The blasting and contamination effects produced by such an explosion are treated and the research now underway on the defensive aspect of nuclear energy warfare is outlined briefly.

37 How Much Radioactive Substance Is a Man Permitted to Take without Harmful Results? Walter Rave. Naturw. Rundschau 2, 326-8(1949) July (in German).

This article discusses the general problems connected with contamination by radioactive elements; the half-lives and destructive powers of several radioactive isotopes such as Sr^{89}, Sr^{90}, I^{131}, Te^{127} and Y^{90} are listed along with the specific areas in which they concentrate upon introduction into the body. The need for care in avoiding contamination by these substances is stressed; it is pointed out that once contamination occurs there is little that can be done to influence or ameliorate the destructive course of the radiations released upon the body.

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38 Radiation Burns, Including Vocational and Atomic Exposures. Treatment, and Surgical Prevention of Chronic Lesions. James Barrett Brown, Frank McDowell, and Minot P. Fryer. Ann. Surg. 130, 593-607(1949) Oct. (See also NSA 2-2216).

Acute and chronic radiation burns and their treatment are discussed. For the treatment of the acute burns, such as those caused by single, large exposures, atomic radiation and the like, rest, sedation, prevention of infection, and alleviation of the severe pain are advised, as well as grafting of open wounds as soon as possible. Chronic burns, commonly seen on the hands of radiologists and due to repeated exposures over a long period of time to small amounts of radiation, are treated by excision and repair of the skin defects with grafts or flaps; the treatment should be done in the early or the quiescent stages, rather than in the ulcerated stage. The authors conclude that the pathology of atomic radiation burns is probably similar to that of the burns under discussion and the same types of therapy will be beneficial; chronic skin lesions in heavily irradiated areas may be prevented by excision and grafting before the chronic changes (coagulation, atrophy, endarteritis of the small arterioles, telangiectasis and similar phenomena) occur.

39 Radiation Protection for the X-ray Technician. Robert B. Tierney and R. E. Deglow. X-Ray Technician 21, 140-49(1949) Nov.

A discussion is presented on the actions, measurement and effects of radiation, and an improved means of radiation detection, consisting of a pocket dosimeter, is described; the dosimeter consists of two sections, an electrometer assembly and a microscope section. The electrometer features a new, rigid, two-point suspension arrangement, utilizing a phosphor bronze wire of relatively large diameter, which supports a quartz fibre; the insulator is polystyrene. Sensitivity, simplicity, accuracy, and convenience are claimed for this instrument.

40 Shielding from Nuclear Radiations. L. A. Ohlinger. Nucleonics 5, 4-15(1949) Oct.

The basic considerations in the design of shields against nuclear radiations from reactors are discussed. Various shielding materials which are effective, and several means of reducing the amount of shielding necessary, are noted. It is suggested that for adequate shielding design further data must be taken on inelastic scattering properties over the entire energy spectra of various materials, on correlations between "poor" and "good" goemetries, on diffusion patterns and behavior of neutrons in thin and thick shields, on the effects of heterogeneous arrangements vs homogeneous arrangements of these patterns, and on the transmission of γ radiation through thick shields and the secondary γ production in shielding. Also a wider knowledge of the effects of radiation on living, as well as inanimate, matter must be obtained.

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41 Slow Neutron Health Monitoring with Nuclear Emulsions. E. W. Titterton. Atomic Energy Research Establishment Report AERE-G/R-362, June 1949. 10p.

Detailed experiments on the use of improved boron and lithium loaded emulsions for slow neutron personnel monitoring confirm the preliminary estimate of AERE-G/R-240 that one observer working full-time can determine fortnightly slow neutron doses for between 100 - 150 individuals. Excellent plates have been developed by Ilfords and of the two loadings boron is preferred since it shows the greater uniformity and higher event density. The method appears capable of an accuracy of 5% without undue elaboration of calibration and measurement.

42 A Survey of Scattered Radiation from Fluoroscopic Units in Fifteen Institutions. Russell F. Cowing and Charles K. Spalding. Radiology 53, 569-74(1949) Oct.

Experiments determining the minimum room size in which a fluoroscopic unit could function and have a low wall-scattering factor are reported; the most efficient location of the unit within the room was also determined. Measurements of the scattered radiation were taken under actual diagnostic conditions and for many types of examination; all the measurements were made with a Beckman beta-gamma survey meter. It was found that several installations presented radiation hazards which could be overcome by using a movable barrier; technicians assisting with the examinations in nearly every instance received more irradiation than the roentgenologist. Upright units were the most dangerous. It is concluded that for units employing tilt and stationary horizontal tables the minimum room size should be 12 by 14 ft; there should be at least 6 ft between the roentgenologist and the closest wall, regardless of the type of examination.

43 Effect of Atropine on Acute Irradiation Sickness in Mice. John C. Larkin. Am. J. Roentgenol. Radium Therapy 62, 547-9(1949) Oct.

Experiments were performed on mice to determine whether the alleviation of the effects of ionizing radiations by antihistamine drugs was due to their anti-histaminic effect or their slight atropine effect. Albino Swiss female mice were irradiated in groups of 10 in a circular chamber by a 200-kv machine; a 1 mm Al filter was used, the distance from the target to the chamber was 30 cm, and the irradiation rate was about 192 r/min. The mice were injected daily, beginning 24 hr before irradiation, with 0.1 cc of a 0.45×10^{-3} M solution of atropine sulfate; the injections were continued to the 15th day. The typical signs of irradiation sickness were observed in all of the control mice; in the treated groups, the symptoms were not noted as early, but frequently mice which exhibited no signs of severe irradiation sickness one day, were found dead the following day. When the radiations exceeded 910 r, the treated groups failed to survive, while all of the control groups receiving 740 r perished. The increase in survival rate which was observed in the treated groups is concluded to be greater than chance probability; the average survival time for the lethal dose of 1,152 r was seven days longer for the treated group. It is concluded

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that: the ionizing radiations must produce multiple injurious reactions; and, the particular effect which atropine produces does not involve the most important of these reactions since the protection afforded by this drug is incomplete.

44 Treatment of Radiation Disease by a Synthetic Antihistaminic Drug. J. A. Salva and M. Badell. Presse med. 57, 888(1949) Oct. 8.

A study is presented concerning the therapeutic qualities of various antihistamines in the treatment of radiation disease. The case studies are divided into three groups: the prophylactic treatment of the radiation symptoms; the curative treatment of patients exhibiting intolerance to irradiation; and, the treatment of the sequellae of irradiation. Several drugs are discussed; among them are benadryl, neoantergan, and phenergan. The results indicate that treatment by phenergan seems to be effective in relieving the radiation symptoms; the drug is well tolerated and conducive to sleep. Phenergan's influence on the capillary changes produced by various agents is also discussed.

45 Stripping Film Technic for Radioautographs. A. M. MacDonald, Jock Cobb, A. K. Solomon, and D. Steinberg. Proc. Soc. Exptl. Biol. Med. 72, 117-21(1949) Oct.

A technic for radioautography is described which makes the developing and staining processes independent and, through the use of stripping film, provides an emulsion of uniform thickness. The method of mounting permits uniform development of the entire emulsion and maintains a fixed tissue-autograph relationship. A table is included which gives the activities required at the surface of the tissue to produce radioautographs of image density 0.1-0.6 above the background and with 15 days exposures to uniform sources of C^{14}, Ca^{45}, P^{32}, I^{131} or Zn^{65}.

46 Advances in the Treatment of Cancer. Stanford Cade. Practitioner 163, 337-44(1949) Oct.

This report summarizes the recent advances in the treatment of cancer. Radiotherapy is mentioned as being particularly useful in the treatment of accessible epithelial cancer, such as cancer of the skin, mouth, tongue, pharynx and larynx, and uterine cervix, as well as such diseases as lymphadenoma, lymphosarcoma, and the leukemias. A review of 30,000 patients suffering from cancer of the uterine cervix revealed that there was a five-year survival rate of 60% for those cases in stage I treated by irradiation; stage II yielded a 41% survival rate. Radioactive isotopes, such as I^{131}, P^{32}, and C^{14} are described and their therapeutic value is stressed. Chemotherapy, hormone therapy and surgery are discussed under separate headings.

47 American Association for Cancer Research, Inc., 40th Annual Meeting. Cancer Research 9, 592-631 (1949) Oct.

Among the papers presented at the 40th Annual Meeting of the American Association for Cancer Research, Inc., Held at Hotel Fort Shelby, Detroit, Michigan, April 16 and 17,

1949, were the following: Tumors of pituitary and trachea in mice after high dosages of radioactive iodine, Aubrey Gorbman; Studies with a radioactive iodotetrazolium compound and with a new tetrazolium salt which yields a blue pigment on reduction, Arnold M. Seligman, Ralph Gofstein and Alexander M. Rutenburg; Age and strain differences in phosphorus metabolism in various endocrine organs of mice, Ralph M. Johnson and S. Albert; Localization of radioactive compounds in tumors, W. G. Myers; The distribution of radioactivity and the metabolic degradation in the mouse of 20-methylcholanthrene-11-C^{14}. William G. Dauben and Dorothea Mabee; Use of starch column chromatography in study of amino acid composition and distribution of radioactivity in proteins of normal rat liver and hepatoma, Paul C. Zamecnik, Ivan D. Frantz, Jr., and Mary L. Stephenson; Some observations on the biochemical effects of beryllium, Robert S. Grier, Mahlon B. Hoagland and Margaret Hood; Biosynthesis of amino acids uniformly labeled with radioactive carbon, for use in the study of growth, Ivan D. Frantz, Jr., and Howard Feigelman; A study of the relative toxicity of N-iodoacetyl amino acids and of tissue distribution of radioactive analogues containing I^{131} in relation to inhibition of growth of sarcoma 37 in Swiss mice, Orrie M. Friedman and Alexander M. Rutenburg; A labile calcium-ribonucleoprotein complex in the region of the liver cell cortex, T. B. Rosenthal and A. I. Lansing; Initial use of high energy deuterons and alpha particles in cancer research, C. A. Tobias, Paul Rosahn, Hal Anger, and John H. Lawrence; Analysis of lymphoma induction by x-ray in mice, George A. Sacher and Austin M. Brues; Effects of irradiation with x-rays on mammary tumor transplants observed in vivo, Ruth M. Merwin, Glenn H. Algire and Henry S. Kaplan; Histological changes produced by a single large injection of radiophosphorus (P^{32}) in albino rats and C3H mice, B. Grad and C. E. Stevens; Effects of chronic irradiation with gamma rays on mammary tumor incidence in $C3H_B$ female mice, Egon Lorenz, Walter E. Heston and Allen B. Eschenbrenner; Local irradiation and the induction of lymphoid tumors in mice, Henry S. Kaplan; Types of transplantable ovarian neoplasms induced by x-rays and their pathogenesis, T. Bali and J. Furth; The effect of regeneration on the rate of protein synthesis and degradation in rat liver, Nancy L. R. Bucher, Robert B. Loftfield and Ivan D. Frantz, Jr.; Distribution studies with nitrogen mustard containing radioactive iodine, Arnold M. Seligman, Alexander M. Rutenburg, and Orrie M. Friedman.

48 Atomic Medicine. C. F. Behrens, ed. New York, Thomas Nelson and Sons, 1949. 448p.

This collection of 21 articles includes a few general discussions of nuclear theory, but most of the material relates to biological and medical applications of nuclear research. Thus, among the topics treated are radiobiology and pathology, the hematology of irradiation, radiation illness, the detection and measurement of radiations, atomic disaster planning, tracer methods in biology, radiophosphorus and radioiodine, radioisotopes of medical interest, radiation effects in dentistry, and research in atomic medicine. Symbols, units, and definitions pertaining to the subject are given in a three-page appendix. A 21-page table of isotopes and their half-lives and emissions is also given.

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49 Austrian Meeting on Cancer. Krebsarzt 4, 209-48 (1949) Aug. 1 (in German)

Among the papers presented at the first Austrian meeting on cancer at Innsbruck on June 17 and 18, 1949, were the following: Radical gland removal after radium treatment for carcinoma of the oral cavity, H. Kunz; Our experiences with the treatment of carcinoma of the uterine cervix, S. Tapfer; On the operation of inoperable ovarian carcinoma, F. Hoff; Concerning eyelid carcinoma, K. Lisch; Theoretical basis of radiation therapy of cancer, E. Ruckensteiner; Horizontal circular roentgen cyclo-therapy, P. Marques and J. Canihac; The five-year results with contact roentgen therapy of malignant skin tumors at the cancer center in Bordeaux, G. Meynard; Views concerning contact roentgen therapy, A. P. Lachapele; Contact roentgen irradiation of laryngeal carcinoma through a thyroid cartilage window, L. Hörbst; and, Results with the small area, short distance roentgen irradiation, F. Hammer.

50 Bilharzial Cancer. Mahmoud Ahmed Afifi. London, H. K. Lewis & Co. Ltd., 1948. 111p.

Part one of this book discusses the characteristics of bilharzial cancer, the principal pathological changes involved, the frequency of the disease and its incidence in various organs of the body. Part two describes the methods of radiological diagnosis of the disease; part three divides the treatment of the disease according to the site of the tumor; the kidney, bladder, prostate, colon, rectum, anal canal, and other sites are discussed separately. A list of 59 references and an index are included.

51 Carcinoma of the Ovary. Malcolm S. Allan and Arthur T. Hertig. Am. J. Obstet. Gynecol. 58, 640-53(1949) Oct.

The incidence, symptomatology, pathology, and methods of treatment of carcinoma of the ovary are among the topics discussed here. Eighty-five cases were treated by deep x-ray therapy, which consisted of total dosages of 3,000-9,000 r; some of the patients did not complete the recommended number of treatments. The results from the combined surgery and post-operative irradiation method were 46% survival for the 5-year period, 36% for the 10-year period, and 14% for the 15-year period; the results from surgery alone were 29%, 20%, and 14%, respectively. 16 references.

52 Changes in the Coagulability of the Blood after Radiation Therapy. The Results of Studies Using the Modified Waugh-Ruddick Test for Increased Coagulability. Seymour B. Silverman. Am. J. Roentgenol. Radium Therapy 62, 541-6(1949) Oct.

The blood clotting times of ten patients, who were receiving radiation therapy for various neoplastic diseases, were determined at intervals by a modified Waugh-Ruddick technique, and blood coagulability curves were plotted. Each patient received approximately 300 r/day and the blood was taken 1-2 hr after the treatment. The radiations were administered at 200 kv with a filtration of 1.0-2.0 mm Cu and at a focal distance of 50 cm. Four typical cases are de-

scribed in detail. The results show that the blood coagulability was reduced by the radiations; in two of the patients a primary increased coagulability was noted when the total dose was 600 r or lower; above the 600 r point, decreased coagulability was uniformly demonstrated. Differences in the degree of decrease of the coagulability were noted according to the area irradiated. Possible sources of error were changes in temperature, foreign bodies in the test tubes, air bubbles in the syringe, etc. About 30 prothrombin time determinations were also made, and in most cases the time was within normal limits. The author feels that the test conducted is a measure of the available thromboplastin, which radiations appear to reduce. Other factors are discussed. 40 references.

53 The Clinical Use of Radioactive Phosphorus in the Surgery of Brain Tumors. Bertram Selverstone, William H. Sweet, and Charles V. Robinson. Ann. Surg. 130, 643-51(1949) Oct.

Thirty-three cases are reported in which radioactive phosphorus, P^{32}, was used to localize tumors of the brain from the surrounding tissue. The method consisted of giving the patient a single intravenous injection of buffered P^{32} at a total concentration of 0.95-4.2 mc, preferably, at least 24 hr before operation. The neoplasm was located at operation by means of a probe counter, since the malignant tissue showed a higher concentration of the isotope than the normal tissue. Successive approaches from different directions were occasionally made in order to demarcate the lesion accurately. Data adequate for the localization of the tumor was obtained in 29 of the cases; the counts for each case are listed. A later communication will report the results in the 13 cases where an attempt was made to demarcate the tumor; the limitations of the procedure when applied to the radical surgery of the gliomas will also be discussed. 11 references.

54 Dermalscleroma. Roberto Restrepo. Bol. inst. nacional radium 1, 210-19(1949) Feb.

The treatment and description of the disease defined by the author as dermalscleroma is presented. The disease is characterized by swelling and induration of the skin; affected areas are red and heated. X-radiations and radium were used for the treatment of these inflammations. Various techniques were employed for the radiotherapy and consisted mainly of radiations from a 100-200 kv machine, filtered by Al of 2-5 mm thickness, with up to 2 mm of Cu added, and delivered at a focal distance of 30-50 cm. The therapy was superficial or deep; the doses varied in length and intensity, the total dosage being 600-2,000 r for each field treated. Four cases are described in detail; these, and most of the other cases noted, showed excellent results. The radiotherapeutic method is, therefore, considered to be of value in the treatment of dermalscleroma.

55 The Distribution and Action of a Radioactive Oxazine Dye in Tumor-Bearing Mice. Henry A. Sloviter. Cancer Research 9, 677-80(1949) Nov.

The radioactive iodine derivative of the oxazine dye Nile blue 2B was administered to a normal dog and to tumor-bearing mice and the distribution of radioactivity in the tissues of these animals was determined. The preparation of this radioactive dye was described in detail in a previous publication. In the dog, the radioactivity was very high in the bile and rather high in the thyroid gland; in the tumor-bearing mice, the concentration of dye in the tumor was of the same order of magnitude as in the liver, kidney, and spleen. The administration, either orally or parenterally, of this radioactive dye to tumor-bearing mice was shown to result in marked prolongation of life of the mice; this prolongation of life was shown to be significantly greater than that acquired from nonradioactive dye.

56 Irradiation of the Nasopharynx: Its Importance in the Treatment of Bronchial Asthma in Children between One and Sixteen Years of Age. W. C. Spain and E. A. Weymuller. Ann. Western Med. Surg. 3, 346-50 (1949) Oct.

Radium therapy was given by means of an applicator containing 50 mg of radium sulfate filtered by a 3 mm monel-metal filter, permitting β rays to pass through the tissue; approximately 75% of the β rays are absorbed within 3 mm by the tissue when this applicator is used. Children with hypertrophied or infected lymphoid tissue of the nasopharynx were the subjects; the applicators were passed along the floor of the nose into the nasopharynx and placed in contact with the lymphoid tissue; five treatments of 8.5 min each were usually given at intervals of 14-21 days; a second series was only undertaken with extreme caution. Of the 43 patients treated in this manner, 20% obtained full relief and 57% obtained partial relief. The authors conclude that the technique described offers a safe and effective means of combatting infective asthma in childhood. 11 references.

57 Low Intensity Radium Element Needles. Charles L. Martin. Am. J. Roentgenol. Radium Therapy 62, 467-92(1949) Oct.

The results of the treatment of a large number of cases of cancer of the face, neck, ear, canthi, lip, oral cavity and cervix, and metastatic cervical lymph nodes by radium needles, and in some cases with additional x-irradiation, are presented. Low intensity needles were planted interstitially and left in place for seven days in each case; the number and pattern of the needles was determined for each case; total doses of 6,000-12,000 γ r were usually delivered. The x-ray therapy technique consisted of the delivery of heavily filtered radiations by a 220-kv machine in daily doses of up to 350 r until a total of 2,100 r was reached. The five-year results for the cases treated by the radium needle therapy exclusively were: for face, neck, and ear cancer—30-36.5%; for lip cancer—24.4-46.8%; and for intra-oral cancer—40.0%. Treatment of metastatic cervical lymph nodes by a technique consisting of planar implantation of radium needles along the lymphatic bed and well beyond the affected nodes, immediately followed, while the needles are in place, by x-irradiation produced a cure rate of 53%. The author concludes that low intensity radium needles constitute an economical and highly effective addition to the radiologist's equipment. 44 references.

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58 Malignant Disease and Its Treatment by Radium. Vol. 2. Stanford Cade. Bristol, John Wright & Sons, Ltd., 1949. 430p. (See also NSA 2-1009).

This book, the second of two volumes on the radium treatment of malignant disease, is based on 3,000 cases which were under the author's care at Westminster Hospital, Mount Vernon Hospital, and elsewhere in England. The specific types of treatment for malignant disease of the mouth, pharynx, larynx, and the neck are presented; the sites of the diseases are discussed separately, and the clinical features, etiology, symptoms, histology, drainage, course, and termination of each type of cancer encountered are described. References appear at the end of each chapter and a general index is included.

59 Proceedings of the French Society of Urology. Semaine Hopitaux Paris 25, 1182(1949) Apr. 10 (in French).

Among the papers presented at the meeting of the French Society of Urology, February 21, 1949, was the following: Contact radiotherapy of vesical tumors with immediate ligature of the bladder, M. H. Duvergey. The method of treatment was limited in its applications since an area of 4 cm^2 was the largest for which it could be used. Excellent results were obtained, however, by the addition of filters since this allowed an effective penetration depth of 2 cm to be established. Of the 22 cases treated by this method, 60% were cured. The author stresses the importance of disinfecting the vesical cavity before a surgical operation.

60 Radiotherapy and Cancer. A. G. C. Taylor, Joan Lassetter, and T. K. Morgan. London, H. K. Lewis & Co., Ltd., 1948. 81p.

This book involves a study of the basis and methods of treatment of cancer in individual sites. Physics, radiology, and such methods as curative and palliative radiotherapy with interstitial radium, radon seeds, and x-rays are discussed. The specific types of therapy approved for such sites of cancer as the buccal cavity and the pharynx, the digestive organs, the respiratory organs, the male and female genital organs, the urinary tract, the skin, the nervous system, the eye and the endocrine glands, and for sarcoma of the bone are described; the radio sensitivities for the typical tumors in each site are given.

61 Radium Dosage; The Manchester System. W. J. Meredith, ed. Edinburgh, E. & S. Livingstone, Ltd., 1949. 124p.

This book presents a complete dosage system covering all phases of mold, intra-cavitary and interstitial γ-ray therapy. Part one describes the clinical aspects of the various methods, the rules for applicator treatments, dosages for cancer of the cervix uteri, and allied subjects; part two covers the purely physical aspects of the subject, describing the physical basis of the planar mold and line systems and the cylinder mold system, physical aspects of interstitial treatments, the calculation of dosage and an additional distribution rule for cylindrical implantations with radium;

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radioautographs are also discussed. Dosage tables and other useful data are included in an appendix and 22 references are listed.

62 Radium Treatment of the Eustachian Tube Lymphatic Tissue in the Therapy of Deafness of Tubal Origin and of the Recurring Otitis of Infancy. M. Cristiani and A. Franciosi. Oto-Rino-Laringologia Italiana 18, 45-65(1949)(in Italian).

A method is described for the treatment of small nodes of lymphatic tissue in the eustachian tube by radium therapy. The method consists of two one-hour treatments every three weeks, employing two applicators carrying 4 mg of radium each; the applicators filter out the β rays and permit γ rays alone to effect the destruction of the tissue. Of 52 cases treated by this method, 41 were rhinogenic deafness cases and 11 were otitis media cases; 70% of the rhinogenic deafness cases experienced almost total recovery of hearing, and in 54% of the otitis media cases middle ear discharge was stopped. The authors conclude that the radium method is most beneficial for cases of this type. 31 references.

63 Reports on the Studies of the Pontifical Academy in Rome, June 4-11, 1949. Krebsarzt 4, 249-52(1949) Aug. 1 (in German).

Among the papers presented during the week of June 4-11, 1949, at the Pontifical Academy in Rome, were the following: Cancerogenic, cancericidal, and mutagenic radiations and materials in mitosis research, H. R. Schinz; and, The influence of microwaves on cancer tissue, E. F. Petritsch. In the first of the above-mentioned articles such agents as short-wave and ionizing radiations and such substances as the nitrogen mustards, phenol, formaldehyde, and mustard gas are discussed as regards their primary, secondary, and cytostatic effects on cytoplasm; the mutation, induction, and defect theories of cancer are also discussed.

64 Results of the Treatment of Cancer of the Breast. Paul Santy, Marcel Dargent, Marcel Mayer, and Simon Batmaz. Bull. assoc. francaise étude cancer 36, 232-71(1949)(in French).

This article discusses in great detail the etiology, morphology, methods of treatment and the prognosis of cases of cancer of the breast. The roles of sex, age, weight, castration, and topographical location on the course of the disease are outlined. Hormone therapy, surgery, radiotherapy, and several combined procedures are discussed and the survival rates are given. Pre- and post-operative radiotherapy doses were generally administered with voltages of 150-200 kv; total doses of 3,000-6,000 r were usually given. Radiotherapy alone consisted of total doses of 1,500-10,000 r. Tables are included which give the results of the various types of treatment. It was found that in the treatment of cases of clavicular recurrences of the disease, radiotherapy appeared to be of some definite benefit, especially total doses of 4,500-10,000 r. It is concluded that no one type of therapy offers maximum results; a combined surgical and radiotherapeutic technique offers the best solution to the existent problem.

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65 Stabilisation of X-ray Therapy Apparatus by Ionization Current. C. G. Clayton and F. T. Farmer. Brit. J. Radiology 22, 669-71(1949) Nov.

An instrument is described which keeps the output of an x-ray therapy tube constant within 1 or 2% over long periods. The current from an ionization chamber in the tube aperture is amplified and used to operate a relay which controls a regulating transformer in the main power supply line and so corrects variations of output in either direction. The automatic return of the transformer tapping to its midpoint, on switching off the x-ray unit, is one of the features of the device.

66 Swiss Society of Radiology, 36th Regular General Meeting. Schweiz. med. Wochschr. 79, 965-7(1949) Oct. 8 (in German and French).

Among the papers presented at the meeting of the Swiss Society of Radiology at Yverdon on 28-29 May, 1949, were the following: Concerning the exponential course of radiation effects, W. Minder; Combination of clinical treatment with x-radiation, H. R. Renfer; First experiences with ultra-radiation treatment, S. Läser and Ch. Marmier; Relative considerations of the limits of roentgen therapy of cancer, A. Rosselet; The chemotherapy of malignant tumors, Georges Bickel.

67 Tumors of the Salivary Glands. Mario Gaitán Yanguas and Aquileo Asmar. Bol. inst. nacional radium 1, 147-87(1949) Feb.

This article discusses the methods of classification of the types of tumors occurring in the salivary glands and the results of different forms of therapy: surgery, radium and telecurietherapy, and x-ray therapy. Of the 55 cases described, 18 were benign tumors; 10 of the benign cases were treated by radiotherapy, the x-radiations being administered alone or after a radium puncture or a combined radium puncture and telecurietherapy procedure. The radiations were usually 4,900-5,400 r total dosage; one case showed complete disappearance of the tumor. Two per cent of the patients were followed for as long as five years after the treatments. Radiotherapy was also used as a palliative treatment, especially in the malignant cases, or post-operatively; doses of 3,700-5,800 r were usually given. In all the cases so treated an immediate reduction in the size of the tumor was noted and in two cases the tumor was controlled for a considerably period of time. The results indicate that there is justification for the use of radiotherapy alone in inoperable cases of adenocarcinoma of the parotid glands. The authors conclude that the mixed tumors of the salivary glands should be classified as benign although they are readily susceptible to degeneration into a malignant form; for these, radical surgery is the best form of treatment. It was also concluded that cylindromas may be cured by x-irradiation and radium therapy. 29 references.

68 Two Devices for Improving Accuracy in X-Ray Beam Direction. I. G. Brown and J. L. Howarth. Brit. J. Radiology 22, 605-8(1949) Oct.

An extension of the technique of using radiographic measuring tapes for determining the location of a lesion in relation to the external mould in radiotherapy is described. The apparatus consists of four grids, comprising sheets of perspex with milled lines dividing the sheets into squares; the squares are marked, placed in position over and behind the region to be treated and radiographed. The exact position of the lesion in the area to be irradiated can be determined. A method to eliminate the inaccuracy in transferring the positions of the fields from the mould to paper for isodose curve plotting is also described. Observations on patients treated by radiotherapy involving the use of these planning methods indicate that accuracy in the localization of the lesions and calibration of the maximum dose can be achieved.

69 The Use of Radioactive Silver for the Detection of Abscesses and Tumors. I. The Concentration of Ag^{111} in Spontaneous and Experimentally Induced Abscesses. Harold D. West, Alfonso P. Johnson, and Charles W. Johnson. J. Lab. Clin. Med. 34, 1376-9 (1949) Oct.

The results of experiments to determine the ability of Ag^{111} (half-life 7.5 days) to concentrate at the sites of spontaneous and experimentally induced abscesses are reported. An injection of 0.1 ml of an incubated solution of streptococcus hemolyticus was made into the right leg of each of a series of albino rats and 48 hr later 0.5 ml of Ag^{111} in the nitrate form was injected in either leg. Three days after the injection of the isotope the animals were sacrificed and the specific radioactivities of the legs, kidneys, liver, lungs, heart, testes, and ovaries were determined by the ashing method. Three animals were also studied for the normal distribution of the isotope. The results indicated that the isotope concentrates in areas of infection; excretion of the isotope by the liver into the intestine was also demonstrated. It is expected that other silver isotopes, such as Ag^{106}, may react similarly and be of benefit in diagnosing the foci of obscure infections within the body; since Ag^{106} emits γ rays, it may be found to be useful therapeutically.

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70 Chemistry and Atomic Energy. R. Spence. Research 2, 115-19(1949) Mar.

The effect of the recent development of nuclear energy upon progress in chemistry is reviewed, with respect to (1) the study of elements previously either unknown or else little studied, and (2) the solution of chemical problems directly connected with the technology of nuclear energy. The areas of chemistry of importance in the development of nuclear technology have been tabulated as to the fields of nuclear technology in which they are utilized. The chemistry fields listed are: inorganic (according to Z), physical, and radiation chemistry. The areas of nuclear technology tabulated are: nuclear physics research, separation of uranium and thorium from ores, pile materials of construction, production of fissile material from piles, production of radioisotopes from piles, enrichment of fissile material by physical methods, e.g., diffusion processes, use of fissile material in reactors, etc., and treatment of radioactive wastes. In particular, a few of the chemistry problems arising in

the production of fissile material from piles and the use of various materials in pile construction are noted. Various developments in inorganic chemistry which are related to the "filling-in" of former gaps in the periodic system and to the discovery of the rare-earth-like properties of the transuranium elements are discussed. Some of the particular nuclear technology problems relating to separation and analysis are considered and the development of a new field of chemistry, i.e., radiation chemistry, is noted.

71 The Effect of Oxygen, Nitrogen, and Hydrogen on Iodide Refined Titanium. Robert I. Jaffee. J. Metals 1, 646-54(1949) Sept.

Oxygen and nitrogen up to 1 at. % increase the electrical resistivity at 25.6°C linearly and 48 to 56 micro-ohm-cm, while hydrogen in the same concentration has no effect. Dissolved nitrogen changes the microstructure of annealed titanium from large Widmanstatten plates to long, narrow Widmanstatten needles. Oxygen refines and makes the Widmanstatten arrangement of the α-Ti plates more regular. Hydrogen does not change the mcirostructure of titanium at 0.25 at. % concentration, but at higher concentrations, some markings of unknown origin appear. Nitrogen has a more potent hardening and strengthening effect than oxygen and decreases the ductility to a greater extent. Hydrogen, when added to 1 at. % either does not affect the mechanical properties, or slightly improves both the strength and ductility. Unalloyed titanium, the titanium-hydrogen alloys, and the 0.25 at. % oxygen alloy could be cold rolled to 95% reduction without edge cracking. The higher oxygen alloys edge cracked at 60-70% reductions, while the nitrogen-containing alloys had considerably less capability for cold rolling without edge cracking. Work-hardening curves were determined for the various specimens.

72 General Chemistry of the Hydrides. A. L. Grunewald. Fairchild Engine and Airplane Corp. Report NEPA-546, June 2, 1948. 26p.

A general review is given in the following topics of discussion: sorption of hydrogen by metals, classification of hydrides, saline hydrides, metallic type hydrides, volatile hydrides, production of hydrides, hydrogenation of metals, reactions of oxides with metals in a hydrogen atmosphere, reaction of an oxide with a hydride in a hydrogen atmosphere, reactions with lithium aluminum hydride, Grignard synthesis, general reactions of hydrides, reactions with metal oxides, reactions with gaseous oxidants, reactions with metals and ceramics, organic synthesis, and diffusion of hydrogen. 20 references.

73 Inorganic Microchemistry. Philip W. West. Anal. Chem. 21, 121-4(1949) Jan.

A review of the literature pertaining to inorganic microchemistry is presented. Greatest emphasis is placed on apparatus, organic reagents, microchemical separations, titrimetric analysis, spot tests, and colorimetric methods, although many articles are cited which refer to more general

aspects of microchemistry. A table of colorimetric determinations is included. 430 references.

74 On the Absorption of Polonium by Mercury in Different Solutions. C. Chamié and H. Filcakova. J. chim. phys. 46, 174-5(1949) May-June (in French).

Polonium is deposited spontaneously on mercury when it is found in solution in the solvents examined (hydrochloric acid, acetic acid; acetone, methylethylacetone, acetylacetone, alcohol, and ammonium hydroxide). In colloidal solution polonium is not absorbed by mercury. Polonium deposit forms an amalgam which diffuses into the mercury mass. That mercury, in contact with the gelatin of a photographic plate, is partially freed from this amalgam is manifested by the photographic images of the atom groups.

75 The Reactions of Gases with Metals at High Temperatures. Daniel D. Cubicciotti, Andrew Dravnieks, and Robert Blevitzky. Illinois Institute of Technology. nd. 49p. (NP-1003).

The rates of reaction of zirconium metal with oxygen gas have been measured at temperatures from 600° to 920°C and pressures of a few cm of mercury. The rates are expressed by equations of the form $w^x = kt$, where w is the weight of oxygen consumed in time t, k is a constant, and x is found to be a function of pressure. The oxides produced in the reaction were identified as mixtures of monoclinic and tetragonal zirconium dioxide. A system for producing oxygen gas containing an excess of atomic oxygen is described. The concentration of atomic oxygen was measured as a function of the variables of the system. A comparison of the rates of oxidation of copper in active and in ordinary oxygen was made at temperatures of 500 to 690°C. and pressures of 0.5 mm to 2.0 mm of mercury. The rates were found to be close to parabolic with the reaction in active oxygen usually more rapid, or as rapid as the reaction in ordinary oxygen, except in one case where active oxygen promoted the formation of cupric oxide and decreased the overall rate of oxidation as a result. Analysis of the scales showed that cuprous oxide formed only on short periods of oxidation, a mixture of cuprous and cupric oxides formed on long oxidations, and active oxygen hastened the formation of cupric oxide. The rates of oxidation of a few other metals were compared in active and in ordinary oxygen.

76 Spontaneous Deposit of Protoactinium on Various Metals. M. Camarcat, G. Bouissières, and M. Haissinsky. J. chim. phys. 46, 153-7(1949) May-June (in French).

Protoactinium in hydrofluoric solutions is spontaneously deposited on strongly electropositive metals in appreciable quantity. The amount deposited increases generally with the electropositiveness of the metal. It appears that the deposit is due essentially to an electrochemical displacement. The variation of the quantity deposited on lead with respect to the concentration follows the isotherm of Langmuir.

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77 Chemical Atomic-Weight Determinations. Friedel Hirschbold-Wittner. FIAT Review of German Science 1939-1946, Inorganic Chemistry I, 1-11. Office of Military Government for Germany, Field Information Agencies Technical, Wiesbaden, Dieterich'sche Verlagsbuchhandlung, 1948 (in German).

The authoritative position gained by the mass-spectrometric method in the field of atomic-weight determinations causes the author to consider the present review as the closing chapter in the history of the determination of these constants by the chemical way, and, incidentally, of the story of the eminent work done by the Atomic Weight Laboratory, Munich, Germany. During the years 1939-1946, several changes in the International Table have been made and the disagreements with the mass-spectroscopical data investigated. The atomic weight of Fe was brought from 55.84 to 55.85, that of Ho from 163.5 to 164.94, and that of Lu from 175.0 to 174.99. New work on N and P gave N = 14.008 and P = 30.974, in agreement with the former Table. The checking of third decimal for S resulted in S = 32.066. The serious discrepancy between the former International Table entry Be = 9.02 and the mass-spectrometric value 9.0126 was resolved, after a new chemical determination has furnished the value 9.013. Another disagreement between the values obtained by the chemical and the physical methods was removed by establishing, chemically, Cu = 63.542 instead of the former 63.57, as against the mass-spectrometric value 63.53 ± 0.01. Similarly, the new chemical value Yb = 173.10 agrees better with the physical one, 173.15, than does the old 173.04. On the other hand, new determinations of the atomic weight of Zn = 65.377 confirmed the disagreement with the mass-spectroscopic value 65.33; similarly, the old Se = 78.96 still holds against the physical 78.94; and the new Sm = 150.37, corrected from the old 150.43, still differs considerably from the mass-spectrographic value 150.12. The review mentions 24 papers, most of them originated from the Munich laboratory and bearing the name of its former head Hönigschmid.

78 Mass-Spectroscopic Determinations of Atomic Weights. Heinz Ewald. FIAT Review of German Science 1939-1946, Inorganic Chemistry I, 13-25. Office of Military Government for Germany, Field Information Agencies Technical, Wiesbaden, Dieterich'sche Verlagsbuchhandlung, 1948 (in German).

The mass-spectrogram permits the determination of atomic weights of isotopes either directly, or indirectly by combining the abundance data with the readings from the Aston packing-fraction curve; the last method, although less accurate than the first one, furnishes atomic weights of heavy elements to within one or two units of the second decimal place; in the years reviewed (1939-1946) both methods were used. The photographic plate, as a tool in high precision work, presents certain defects, such as differences from plate to plate, or the indefiniteness of the relationship between the darkening and the abundancy; this caused, in many cases, the abandonment of the plate in favor of an electrometric set-up. The situation changed, however, with the introduction of a new device (Mattauch and Ewald, Naturwissenschaften 31, 487 (1943); Z. Physik 122, 314(1944)): together with the spectrum to be investigated, the plate receives that of another poly-isotopic element, whose known isotopic abundances can then be plotted against the measured darkenings; the "curve" thus obtained is used as a standard for the determination of abundances of the substance under study. In a further improvement of this method, different parts of both spectra are obtained, with different exposures, on the same plate; in this way, strongly differing abundances can be treated with comparable degrees of accuracy (Ewald, Z. Physik 122, 686(1944)). Two mass-spectrographs were in use. One, of the Nier type, was constructed by Paul and used by him and others for atomic weight and isotopic abundance determinations of Rb, Tl, K, Ne, Ag, and N. It was with the other instrument, the Mattauch-Herzog spectrograph, that the working-out of the photographic procedure, described above, was done; the elements investigated were Hf, Cu, Ru, Ni, W, Nd, and Sm; another problem was the testing of the method, suggested by Hahn et al (Naturwissenschaften 25, 189(1939)), for the determination of the geological age of Sr-containing minerals. A new Mattauch mass-spectrograph was constructed by Ewald (Z. Naturforsch. 1, 131(1946)); it has a resolving power M/dM that exceeds 26,000; a section of this instrument is shown. A table of all isotopes investigated is given. The paper mentions 32 references.

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79 A Preliminary Note on Nuclear Periodic Scheme in Three Dimensions. S. Podgor. Phys. Rev. 76, 1271 (1949) Oct. 15 (Letter to the editor).

In order to illustrate better how the properties of nuclei vary and to aid in discovering periodicities that exist, it seemed worth while to arrange a nuclear periodic scheme analogous to the atomic periodic chart. However, since in the ordinary nuclear chart the isotopes proceed along two dimensions, the nuclear periods have to advance along the third dimension. With the assistance of the Segré chart, the system which consists of successive planes has been built up. Each plane starts with nuclei having a complete shell in either neutrons or protons, and ends with nuclei of the next complete shell in either nucleon. The first three planes are shown on a diagram and the complete scheme of seven planes is outlined. The arrangement should be very suggestive in bringing together species that have similar properties since it will tend to line up nuclei that are at the same stage of starting or completing a shell in either neutrons or protons.

80 The Present-Day Periodic System. K. E. Zimens. Trans. Chalmers Univ. Tech., Gothenburg, No. 78, 18p.(1948) (in Swedish).

A brief history of the periodic system is given and an arrangement for the whole system including the isotopes and radioactive series is suggested.

81 A Hood for Work with Radioactive Isotopes. A. K. Solomon and C. A. Foster. Anal. Chem. 21, 304-6 (1949) Feb.

A hood constructed for preliminary work with radioactive materials as required for small scale chemical and biological experiments (i.e., the equivalent of 500 mc of radium)

is described. The sides, back, and bottom of the hood are constructed of 8 in. of concrete and 0.5 in. of lead. The equivalent thickness of the bottom is appreciably greater; in view of the oblique path the rays must take, the shielding is equivalent to approximately 12 in. of concrete plus the lead. The ceiling is also 8 in. thick, but has no lead because the floor of the story above is 5.5 ft above the top of the hood. The front of the hood is closed by 2.5 in. of lead, cast in steel frames. A removable stainless steel pan with a 1 in. turned-up lip rests on the bottom. Waste escapes through a stainless steel sink designed for removal and relatively easy replacement; it is backed by 0.5 in. lead sides and bottom. From the sink, the waste passes through a sediment trap before entering the soil line. The air is exhausted by a fan mounted in a chamber under the roof. A modification of the design is presented for intense sources of radioactivity in which the front consists of two removable lead-filled steel strakes. An aperture in the bottom strake has an opening 22 in. wide by 12 in. high, which can be covered by a lead-filled steel door. The door, which rolls on steel rollers on a brass track, closes the aperture with an overlap of 2 in.

82 Laboratory and Workshop Notes. London, Edward Arnold and Co., 1949. 272p. 195 illustrations.

In this compilation of useful notes which have appeared in the J. Sci. Instruments over a period of 25 years, the following topics are treated: (1) laboratory and workshop tools, processes, and devices, (2) clamps, supports, and agitators, (3) soldering, brazing, and welding, (4) glass manipulation and silvering, (5) vacuum and pressure techniques and devices, (6) electrical and magnetic devices and techniques, (7) optical devices and techniques, and (8) devices for liquids and gases.

83 Remote Pipetting Apparatus for Dispensing Solutions of Radioisotopes. Manuel Tubis, Clare Doan and Raymond L. Libby. Science 110, 431-2(1949) Oct. 21.

A remote pipetting apparatus for the handling of "hot" solutions is described which can easily be assembled from available materials. The unique feature of this apparatus is the use of a manometer for measuring the delivered volume which can be placed at the site of the operator at any desired distance from the radioactive source. Filling and delivery from the pipet are accomplished by turning a micrometer screw attached to the plunger of a syringe. The main parts of the apparatus are the aluminum syringe assembly, the manometer and scale, the pipet support and arm, and the pipet. The apparatus is shown and tabulated data are given which indicate that the accuracy of the delivered volumes compares favorably with that obtained by hand pipetting from calibrated pipets.

84 Universal Microapparatus: Filtration, Extraction, Reflux, Distillation, Homogenization, Centrifugation, and Drying in the Same Apparatus. Clyde A. Dubbs. Anal. Chem. 21, 1273-6(1949) Oct.

A description is given of a simple microapparatus which can be used alone to process small amounts of solid material through a series of common unit operations without vessel-

to-vessel transfer and resulting high percentage loss of material. The original form of the apparatus is attributed to Barker and is described by Allen et al (Arch. Biochem. 14, 335 (1947)). The improved form differs from the Barker apparatus by the inclusion of a special disk assembly that effectively adapts the design to a universal apparatus. For radioactive tracer work the apparatus presents a means of extended processing in a closed system. Other advantages are discussed. 6 figures.

85 New Titrimetric Methods for Thorium. Charles V. Banks. AECD-2735, nd. Decl. Nov. 2, 1949. 67p.

A brief account of the history of thorium has been presented. The present analytical methods for determining thorium have been discussed and found to be largely gravimetric. Because of a definite need for a rapid, accurate method for determining thorium, a study of the titrimetric determination of thorium was made. This study has resulted in the development of a new oxidimetric method in which thorium is precipitated as the normal molybdate, and the molybdenum equivalent to the thorium is reduced and titrated. This method was found to work very well in the presence of calcium and uranium but not so in the presence of the rare earths. Molybdenum can be conveniently separated from certain ions as thorium molybdate, and this method has been successfully applied to the analysis of uranium-molybdenum alloys. A new potentiometric method for determining thorium has been devised in which the thorium is titrated with ammonium paramolybdate and the endpoint detected by means of a molybdenum-calomel electrode system. 56 references.

86 Beryllium Sampling Methods. Thomas E. Shea, Jr. U. S. Atomic Energy Commission Technical Information Division Report TID-261, July 1948. 6p.

A general procedure and necessary equipment are described for collection on filter paper of beryllium metal and beryllium compounds (BeO, $BeSO_4$, BeF_2, $Be(OH)_2$) found in the atmosphere.

87 Determination of Iodine 131 in Urine. R. R. Edwards, W. A. Reilly, and R. G. Holmes. Proc. Soc. Exptl. Biol. Med. 72, 158-61(1949) Oct.

A method for the determination of I^{131} in urine is described, which consists of a dipping counter mounted on a modified microscope base utilizing a blackened test tube with a sample large enough to cover the sensitive area of the tube. It is concluded that the counting of γ radiations is greatly facilitated by this procedure.

88 Determination of Microgram Amounts of Thorium. P. F. Thomason, M. A. Perry, and W. M. Byerly. Anal. Chem. 21, 1239-41(1949) Oct.

A method for determining thorium in the range 5 to 80 micrograms has been developed, using 1-(o-Arsonophenylazo)-2-naphthol-3,6-disulfonic acid. Uranium and the rare earths do not interfere in amounts less than 1000 micrograms and interference from iron can be lessened by reduction to the ferrous state.

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89 Determination of Zirconium by Precipitation from Homogeneous Solution. Hobart H. Willard and R. B. Hahn. Anal. Chem. 21, 293-5(1949) Feb.

Zirconium can be precipitated quantitatively from solutions 3.6N in hydrochloric or sulfuric acid by adding 15 to 20 ml of trimethyl phosphate and heating for 12 to 15 hr. The precipitate obtained is a mixture of zirconyl methyl phosphate, $ZrO[H(CH_3)(PO_4)]_2.2H_2O$, and zirconyl phosphate, $ZrO(H_2PO_4)_2$. Upon ignition at 900 to 950°C this precipitate is completely converted to zirconium pyrophosphate, which is weighed. The method can be used to determine zirconium in samples containing from 2 to 60 mg of zirconium oxide. Antimony, bismuth, cerous, and stannic ions interfere. Large amounts of ferric, titanium, thorium, and uranyl ions give high results. When acid solutions containing zirconyl ions are treated with an excess of metaphosphoric acid, a soluble metaphosphate complex is formed. A precipitate of zirconyl phosphate is slowly deposited at room temperature. The precipitate thus obtained is more dense than the precipitate formed by direct addition of a soluble orthophosphate, although not so dense as that obtained by precipitation with trimethyl phosphate. This precipitate does not decrepitate upon ignition and is completely converted to zirconium pyrophosphate by heating at 900 to 950°C. Metaphosphoric acid can be used to determine zirconium in samples containing from 0.2 to 200 mg of zirconium oxide. Best results were obtained by adding a large excess of metaphosphoric acid to solutions 3.6N in sulfuric acid. Bismuth, stannic, and perchlorate ions interfered.

90 Fluorescence Test for Thallium in Aqueous Solution. Claude W. Sill and Heber E. Peterson. Anal. Chem. 21, 1266-8(1949) Oct.

A method for the qualitative detection of thallium, based upon the bright blue fluorescence produced in saturated sodium chloride solutions under the influence of short-wave ultraviolet light, is described. No other ions produce fluorescence that would be mistaken for that of thallium, and all known interferences are eliminated by simple procedures. Fluorescence is visible at a thallium concentration of 1 to 50,000,000 when the depth of solution observed is 4 in. A short-wave ultraviolet lamp is the only special equipment needed.

91 Iodometric Semimicrodetermination of Thallium in Ores and Flue Dusts. Claude W. Sill and Heber E. Peterson. Anal. Chem. 21, 1268-72(1949) Oct.

An accurate semimicromethod for the determination of thallium present in amounts as low as a few thousandths per cent is described. Sample decomposition is effected by pyrosulfate fusion, followed by separation of thallium from essentially all interferences by extraction from ammoniacal citrate-cyanide solution with a chloroform solution of dithizone. The isolated thallium is then determined by an iodometric procedure. Among the conditions for maintaining a stoichiometric reaction between thallium and iodide, the most important is the thallium-iodide ratio. The effects of starch, ultraviolet light, acidity, volatilization of iodine, and extraneous metals on the titration are discussed.

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92 A Method for the Quantitative Analysis of the Allotropic Varieties of Cobalt by Means of X-rays. Max Sage. Compt. rend. 228, 572-4(1949) Feb. 14 (in French).

The author selects adjacent lines on a powder diagram, one belonging to the cubic, the other to the hexagonal structure. The ratio of intensities gives the composition of the sample, with the aid of a theoretical relation. The validity of this relation is verified by measurements on two samples of known structure. The method is capable of giving an absolute determination of the composition of cobalt, correct to within 5%. Detailed results will be published later.

93 Spectrochemical Determination of Beryllium in Microquantities. E. C. Barnes, W. E. Piros, T. C. Bryson, and G. W. Wiener. Anal. Chem. 21, 1281-3 (1949) Oct.

A spectrochemical procedure has been developed, using a conventional direct current arc, for the quantitative determination of beryllium in amounts as low as 0.04 μg of beryllium per liter of urine. The sample is prepared by a phosphate precipitation to which aluminum is added to act as an internal standard. The amount of beryllium is determined by comparing the density of Be 2348.6 A to Al 2321.6 A. In addition to the determination of beryllium in urine, the method has been successfully applied to tissue and air samples.

94 On Thermogravimetric Analysis of Precipitates. XXVII. Quantitative Analysis of Thorium. Thérèse Dupuis and Clement Duval. Analyt. Chim. Acta 3, 589-98(1949) Sept. (in French) (See also NSA 3-947).

The authors gravimetrically determined thorium after precipitation with various organic and inorganic reagents such as ammonia, hexamethylene tetramine, iodic acid, sodium thiosulfate, and sebacic acid. They found that in the course of the drying or calcination of precipitates serving for the determination of thorium, it was necessary to employ certain temperatures in order to obtain an accurate weight of the corresponding bodies. Of all the methods studied, preference was given to the method using sebacic acid. 33 references, 3 graphs.

95 The Ultra-Violet Fluorimeter by Hilger and Watts Limited. C. N. Davey and C. D. Florida. Atomic Energy Research Establishment Report AERE-EL/R-337, May 1949. 7p.

The design and testing of a fluorometer constructed by Hilger and Watts, Ltd., in which all the components are arranged on a horizontal axis, are described. This instrument consists of a source of ultraviolet light, a lens and filter system, a sample holder, another lens and filter system, and a device for measuring fluorescent light. The instrument is applicable to the method of uranium analysis of Neuman et al (J. Biol. Chem., March 1948) which consists, briefly, of fusing the sample with a fusion mixture containing a percentage of sodium fluoride. This fused sample fluoresces upon illumination with ultraviolet light, and the

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intensity of fluorescence is a measure of the quantity of uranium present. Suggestions for improvement of the instrument are included.

96 A Versatile Microinjection and Micropipetting Syringe. John B. Buck. Rev. Sci. Instruments 20, 676-7 (1949) Sept.

A screw-driven microinjection syringe capable of delivering volumes as small as 0.1 mm^3 with statistically good reproducibility is described. It features interchangeable impellers mounted on a sliding way for simultaneous availability of coarse and fine adjustment, and a mechanical positioner permitting known and reproducible fractional revolutions of the control knob.

97 X-ray Absorption Measurements: Comparative Method for Chemical Analysis Based on Measurements with Multiplier Phototube. P. D. Zemany, E. H. Winslow, G. S. Poellmitz, and H. A. Liebhafsky. Anal. Chem. 21, 493-7(1949) Apr.

A comparative method of measuring x-ray absorption has been devised to reduce the errors of the direct method, used for exploratory analytical work previously reported (Anal. Chem. 19, 861, 866(1947)). In the comparative method, there is rapid commutation in the x-ray beam from the unknown to a suitable standard. The method has been applied with satisfactory results to the identification of pure compounds, the determination of tetraethyllead fluid in gasoline, and the determination of sulfur in crude oils. Deviations that can complicate the interpretation of results are discussed, and experimental data on the zirconia-hafnia system are presented to illustrate one such type of deviation.

98 Chemical Procedures Used in Bombardment Work at Berkeley. W. Wayne Meinke, comp. AECD-2738, Aug. 30, 1949. Decl. Oct. 15, 1949. 257p.

This compilation begins with some general remarks applicable to chemical separations from targets that have been bombarded with high energy particles. Separation procedures for specific elements are then listed by atomic number. Each procedure gives the target material used for producing the element, the type of bombardment necessary, time and equipment necessary for the chemical separation, the yield and degree of purity, and the details of the separation procedure listed step by step. No procedures are given for elements with atomic numbers 90 or above.

99 Cation Exchange Equilibria at Constant Ionic Strength. S. W. Mayer. Naval Radiological Defense Laboratory Report AD-155(0), Aug. 24, 1949. 6p.

Extensive investigations by Harned and Owen (The Physical Chemistry of Electrolytic Solutions, Reinhold p. 454 ff. (1943)) have shown that very frequently in a mixture of electrolytes at constant total ionic strength, the logarithm of the activity coefficient of an electrolyte varies linearly with its ionic strength. When the ions involved in an exchange are of equal charge, the total ionic strength remains constant.

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For such exchanges, the principle of linear variation of logarithm of mean activity coefficient has been applied in this note to develop a simple relationship for the equilibrium concentrations in both phases.

100 Chromatographic Separation of Actinium from Lanthanum. J. T. Yang and M. Haïssinsky. Bull soc. chim. France, Nos. 5-6, 546-7(1949) May-June (in French).

Mixtures of nitrates of lanthanum containing La^{140} and $MsTh_2$ (Ac^{228}) were used to study the chromatographic separation of actinium from lanthanum. The radio-lanthanum was obtained by neutron or deuteron irradiation in a cyclotron, and the $MsTh_2$ was prepared from 0.25 mc of $MsTh_1$ (Ra^{228}) (Haïssinsky, Compt. rend. 196, 1788(1937)). The quantities used in the experiments were 10^{-7} mg of mesothorium and 10-100 mg of lanthanum. The chromatographic column (48 cm by 10 mm) consisted of the synthetic resin amberlite IR-100 previously treated with 6% HCl, water, and ammonium citrate. The elution was done with an ammonium citrate solution. The activity of the eluant was determined directly by a Geiger-Mueller counter surrounded by a spiral which was attached to the end of the column, and a sample was also taken of each separate washing to determine the decrease of activity per unit of time. The measurements indicate that for all the concentrations of citrate used, the lanthanum was eluted before the actinium, and the separation of the two elements was more complete as the citrate concentration decreased. Curves are included which illustrate the concentration, pH, and time factors. It was stated in conclusion that in chromatographic separations, actinium is situated in a normal position with relation to lanthanum. The optimum conditions for their separation were citrate concentration of less than 1% and a pH of 5.0.

101 The Extraction and Purification of Xenon and Krypton Isotopes from Neutron Irradiated Uranium. W. J. Arrol, K. F. Chackett, and S. Epstein. Can. J. Research, 27B, 757-63(1949) Sept.

Both long-lived and stable isotopes of krypton and xenon are formed as the result of the slow neutron fission of U^{235}. Methods are described for the extraction of these gases from massive neutron irradiated uranium metal, for separating them from contaminating gases and from each other and on measuring them in a McLeod gauge (the amounts of uranium being of the order of 50 g. and the rare gases of the order of 10^{-3} cc. at N.T.P.). An accurate value of the ratio of fission xenon to fission krypton is given. Further experiments are described on Geiger-Mueller counter measurements of the long-lived krypton isotope.

102 Ion Exchange Studies. I. The Sodium-Hydrogen System. J. F. Duncan and B. A. J. Lister. Atomic Energy Research Establishment Report No. AERE-C/R-338, May 1949. 36p. (See also NSA 2-1187 and 3-1875).

The mass action constants governing the exchange of sodium ions and hydrogen ions between solution and two ion exchange materials (Dowex 50 and Amberlite IR-100 H) have been de-

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termined, (a) by a batch equilibrium process, (b) by the saturation of a chromatographic column of exchanger with solutions of different sodium-hydrogen ion ratio, and (c) by calculation from the elution rear boundary of a chromatogram obtained when sodium ions are removed from the column with acid. The chromatographic technique used consists of measuring the sodium ion concentration in the exchange column by means of radioactive Na^{24} tracer and GM counters. It has been shown that the mass product is approximately constant over the greater part of the exchange-isotherm, but rises significantly for low values of the molar fraction of sodium ions. 14 references.

103 Separation of Beryllium from Iron by Solvents. R. S. Young. J. Chem. Education 26, 357(1949) July.

The author maintains, contrary to a statement by Treadwell and Hall (Analytical Chemistry, II. Quantitative Analysis, New York, John Wiley & Sons, 1942), that in the separation of iron as ferric chloride by extraction with ether, beryllium chloride remains in the lower aqueous layer and does not dissolve in the ether. Traces of iron and of beryllium remaining in the lower aqueous and upper ethers layers, respectively, can be removed by a second extraction with ether and acid. The results confirm the observation of Hillebrand and Lundell (Applied Inorganic Analysis, New York, John Wiley & Sons, 1929) on the behavior of beryllium in an ether separation. It is also shown that Be separation from iron with amyl acetate is satisfactory. The procedure used is similar to that recommended by Wells and Hunter (Analyst 73, 671(1948)), using approximately 5 ml of conc HCl and 0.2 ml of conc. H_2SO_4, with 15 ml of amyl acetate per gram of iron. The amyl acetate layer is washed with an additional 2 ml of the same acid mixture and the two acid extracts combined.

104 Separation of Zirconium and Hafnium with Anion Exchange Resins. Kurt A. Kraus and George E. Moore. J. Am. Chem. Soc. 71, 3263(1949) Sept. (Letter to the editor).

Experiments which have been carried out have demonstrated that separation of Zr(IV) and Hf(IV) by anion exchange is feasible, although the separation achieved is by no means at its optimum. Partial separation of Zr(IV) and Hf(IV) at room temperature was achieved using a 107-cm column of 200-230-mesh Dowex-1 (a quaternary amine anion exchanger) of 0.0226 cm^2 section, and a mixture of 0.5M hydrofluoric acid-1.0M hydrochloric acid as eluent. Flow rates of about 0.3 $ml/cm^2/min$ were used. Under these conditions elutions were relatively rapid (complete elution in about one and one-half days). The experiments were carried out with tracer concentrations of zirconium and 0.2 mg of hafnium, using Zr^{95} ($T_{1/2}$ = 65 days) and Hf^{181} ($T_{1/2}$ = 55 days) as tracers. Zirconium and hafnium were identified radiochemically and in particular the hafnium content of the various elution fractions was determined by delayed coincidence counting taking advantage of the metastable daughter Ta^{181} ($T_{1/2}$ = 20 μsec) of Hf^{181}. From results it was shown that the earlier fractions were highly depleted of hafnium, while the last fractions were practically pure hafnium.

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105 Annual Reports on the Progress of Chemistry for 1948. Great Britain, Richard Clay and Co., Ltd., 1948. 379p.

Among the reports presented in this collection is a chapter on the chemical reactions induced by ionizing radiations. This chapter discusses radiation sources, techniques and methods, the energy transfers involved, primary and secondary reactions, ionic yields, types of substances and mixtures and their characteristics under radiation conditions, and other related subjects. Other chapters cover specialized problems in the fields of organic, analytical, and inorganic chemistry, and biochemistry.

106 An Anomalous Luminescent Effect. J. E. Underwood. Electrochem. Soc. J. 95, 319-23(1949) June.

The luminescence caused by the radiations emitted from radon, when confined over a plane surface of phosphorescent zinc sulfide, is not uniform. Bright and dark areas occur in a variety of unpredictable configurations and these areas slowly change their form and light intensity with time. Although some of the changes in the luminosity are apparently affected by a magnetic field, the real cause of the effect has yet to be found. The luminosity is sufficient to produce photographs through short-time exposures without film fogging. Such photographs serve as records of the effect.

107 Effect of Soft X-rays on Vitamins (Niacin, Riboflavin, and Ascorbic Acid). Bernard E. Proctor and Samuel E. Goldblith. Nucleonics 5, 56-62(1949) Sept. (See also NSA 1-1036).

The effects on the vitamins niacin, ascorbic acid, and riboflavin of irradiation with soft x-rays from a 50-kv source are described. A dose-rate of 14,890 r/min was obtained by using unfiltered radiations at a distance of 10 cm from the target; this was the procedure uniformly used on the 1-ml samples of the various solutions. A total dosage of 100,000 - 500,000 r was given to the riboflavin samples; niacin samples received 50,000 - 500,000 r; and ascorbic acid samples received 10,000 - 200,000 r. Niacin underwent partial destruction at dosage levels of 400,000 r or more and a concentration of 50 $\mu g/ml$, as compared with 75,000 r for hard x-rays produced by a 3,000-kv source; destruction of riboflavin with soft x-rays began at 100,000 r and at 500,000 r the destruction amounted to 68%; ascorbic acid proved to be extremely sensitive in dilute solution, as little as 10,000 r having some measurable effect. The conclusions are that: the ionizing radiations affected the vitamins in accordance with the indirect action theory (each vitamin was more sensitive to irradiation in higher dilution); niacin when mixed with ascorbic acid suffered more destruction, presumably because of its greater competition for the activated water molecules; riboflavin was protected by oxalic acid; and, on the basis of the data, x-rays produced at 3,000 kv were far more destructive to niacin and riboflavin than the soft rays of 50-kv origin which were used here.

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108 Photographic Chemistry. Pierre Glafkidès. Paris, Publications Photographiques et Cinématographiques Paul Montel, 1949. 607p. (in French).

One chapter of this extensive book is concerned with x-radiations and electrons in photography and discusses the sources of x-radiations, their photographic action, emulsions especially sensitive to x-rays, the photographic action of electrons, and the role of ionizing particles in photography; formulas and reactions are also given in this brief section.

109 Polymerization by γ Rays. Adolphe Chapiro. Compt. rend. 229, 827-9(1949) Oct. 24. (in French) (See also NSA 3-2135)

Previous work on the polymerization of styrolene by gammas (Compt. rend. 228, 1490(1949)) has been extended to the domain of highly diluted solutions. The dilution affects both the rate of polymerization and the character of the polymer, the effect depending on whether or not the polymer is soluble in the solvent. Results are cited for solutions in acetose, benzene ether, carbon tetrachloride, alcohols, and several other solvents.

110 Radiation Effects on 2, 3, 5-Triphenyltetrazolium Chloride Solutions. Z. S. Gierlach and A. T. Krebs. Am. J. Roentgenol. Radium Therapy 62, 559-63(1949) Oct.

Two series of investigations on the effects of radiations on 2, 3, 5-triphenyltetrazolium chloride (TTC) were performed: photochemical studies, involving solar and ultraviolet irradiation; and radiochemical studies, involving α radiations from polonium and x-radiations. The strengths of the polonium preparations were 2, 0.1, and 0.0004 mc, respectively; x-ray exposures were up to 32,500 r, and were given at the rate of 250 r/min from a 550-kv source through a composite filter equivalent to 9 mm of Cu. Alpha, ultraviolet, and roentgen rays were found to reduce TTC to its red water-insoluble formazan. It was found that with the ultraviolet irradiation, wavelengths longer than 3,650 A did not reduce the salt; the millicurie strength, exposure time, and the concentration of the tetrazolium were found to be significant in the α-ray reduction process; with roentgen radiations, relatively high dosages were needed to elicit an effect (at least 32,000 r in air). Other factors, such as pH and temperature, are discussed. 21 references.

111 A New Method of Investigating X-ray Absorption Spectra in Gases. Gösta Brogren. Arkiv Mat. Astron. Fysik 36 B, No. 2 (1948). 4p. (See also NSA 2-1851).

The x-ray absorption edges of the spectra of argon and amyl chloride gases were investigated by means of a new method in which the gas investigated constituted the filling of a Geiger-Mueller tube. The method has the particular advantage of increasing the available intensity for a region of soft radiation. The absorption was investigated by using a concave-crystal spectrograph of a Johann type, described earlier by Sanner (Dissertation, Uppsala, 1941), in order to determine whether the efficiency of the secondary radiation

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in releasing photoelectrons is high enough to make the method practical. The plate-holder was removed and a movable slide on which the Geiger-Mueller tube was mounted was substituted for it. The results obtained using the new method are compared with those obtained in the usual way by means of an absorption chamber and a xenon-filled Geiger-Mueller tube. Good agreement is obtained, and the details of the secondary structure are very distinct in the curves obtained with the new method.

112 A Recording Spectrometer for the Far Infrared Spectral Region. William H. Haynie. Ohio State University Research Foundation Report 14, Supplement A, Aug. 15, 1948. 48p. (NP-1008).

This paper describes the design and construction of an evacuable spectrophotometer to be used for investigating the far infrared spectral region. Detailed consideration is given to the design of the optical system, the chief criterion being that the maximum amount of available power reach the detector. The spectrophotometer automatically records per cent transmission of a given sample medium as a function of wavelength. The instrument is composed of three groups of parts. These are, respectively, designated as: (1) the spectrometer, (2) the photometer, and (3) the detector-amplifier-recorder-control system. The spectrometer employs as the dispersing element an echelette grating mounted on a table rotated by a worm and wheel. The single collimating-focussing mirror is an off-axis paraboloid. It is proposed to use a superconducting bolometer as the radiation detector. The photometer unit is basically made up of six elements, namely, the source and source focussing mirror, the sample cell which contains a converging mirror, the reference cell which also contains a converging mirror, the beam changer which alternately sends the beam through the sample and reference cells, the intensity control in the reference beam, and the mirror that focusses the beam on the entrance slit of the spectrometer.

The detector-amplifier-recorder-control system is part of a null arrangement. As a spectral region is being scanned, differences in the absorptivity of the sample with wavelength cause the detector to send a pulsating signal of the frequency of the beam changer into the specially designed low-noise amplifier. The output of the amplifier energizes a servomechanism which positions the intensity control so that the intensities of the reference and sample beams are restored to equality, thus reducing to zero the magnitude of the pulsating signal from the detector. The position of the intensity control which is related to the transmissivity of the sample is recorded by a potentiometer type strip chart recorder whose time axis is a function of the wavelength of the radiation. The design of the instrument has been completed with the exception of the servo system and a few small details. Most of the components have been constructed, but the complete instrument has not yet been assembled and tested.

113 Thallium Isotope Effect in the Band Spectrum of Thallium Bromide. P. Tiruvenganna Rao. Indian J. Phys. 23, 265-8(1949) June.

The bands of thallium bromide, excited by a high frequency discharge through the vapor, have been photographed in the

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first order of a 10-ft concave grating. The isotope effect due to Tl^{203} is established for the first time from measurements on the splitting observed in many of the band heads in the 4100-4300 A range. The lines are tabulated and the spectra plates are shown.

114 Theory of Complex Spectra. IV. Giulio Racah. Phys. Rev. 76, 1352-65(1949) Nov. 1.

The calculation of the coefficients of fractional parentage and of the energy matrices for the configurations f^n is simplified very much by the use of the theory of groups. Tables of results are given. 24 tables.

115 Status of Biological Syntheses of Radioisotope Labeled Compounds. Nathan H. Woodruff and E. Eugene Fowler. J. Tenn. Acad. Sci. 24, 229-43(1949) Oct.

This report discusses the methods involved in the production of labeled materials from plants, animals, and animal preparations. Some methods, such as photosynthesis and biosynthesis of organic metabolites (utilizing such microorganisms as Propionibacterium pentosaceum, Clostridium clyindrosporum, and Clostridium thermoaceticum) are discussed; current work on C^{14}- and S^{35}-labeled plant materials is outlined. Some limitations encountered when using intact animals for the production of labeled organic metabolites are presented: (1) the labeling materials introduced are usually lost in relatively large quantities through excretion; (2) labeling materials are often metabolized into products other than those of interest; (3) labeling materials are often diluted to a high degree by unlabeled materials present in the animal's body; and, (4) the labeling materials have yet to become available in sufficient quantities to permit general and complete labeling of intact animals. However, some attempts have been successful, notably the production of tagged blood cells for the study of whole blood preservation; specific animal preparations, such as tissue slices, homogenates, or separated enzyme systems have also been used to advantage. Some current work on the animal preparations method is outlined and includes studies involving C^{14}-, P^{32}-, and I^{131}-labeled compounds. The authors conclude that the numerous examples cited of investigations utilizing compounds labeled by biosynthetic methods give evidence of the wide-spread interest in this field. 53 references.

116 The Synthesis of Tetraethylthiouram Disulphide (Antabus) Labelled with Radioactive Sulphur. Lorentz Eldjarn. Acta Chem. Scand. 3, 644(1949) (Communications).

Tetraethylthiouram disulfide labeled with S^{35} was synthesized in order to follow the path of the compound in the body and thus to study its peculiar action on the metabolism of ethyl alcohol. S^{35} was available as sulfuric acid in 0.25 N H_2SO_4. The labeled sulfate together with carrier sulfate was precipitated as $CaSO_4$ and reduced to CaS. CaS was transformed in turn to K_2S by liberating H_2S with HCl. The labeled sulfur

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was brought into CS_2 by an exchange reaction between labeled K_2S in water and unlabeled CS_2:

$$S^* + CS_2 \rightleftharpoons CS_2S^{*--} \rightleftharpoons S^{--} CSS^*$$

When equilibrium was established the labeled sulfur was distributed between the two phases according to their sulfur content. In this way, a yield of 50% per run of radioactive CS_2 was obtained. The labeled CS_2 was reacted with diethylamine and KOH to give potassium diethyldithiocarbamate. The oxidation to tetraethylthiouram disulfide was achieved by means of sodium tetrathionate, and the compound was recrystallized from absolute ethyl alcohol.

117 The Solubility of Ytterbium Oxalate and Complex Ion Formation in Oxalate Solutions. Carl E. Crouthamel and D. S. Martin, Jr. AECU-371(ISC-58), July 30, 1949. 12p.

Yb^{169} has been used for radiochemical studies of the ytterbium-oxalate system equilibria in buffered solutions at 25°C. The data are interpreted on the basis of the formation of the ionic species Yb^{+3}, $Yb(C_2O_4)^+$, and $Yb(C_2O_4)_2^-$. The ion, $Yb(C_2O_4)_3^{-3}$, is apparently not formed in appreciable concentrations. Instability constants for the complex ions and a solubility product are computed. These equilibria yield reasonable values for the specific conductance of saturated solutions of $Yb_2(C_2O_4)_3$ in pure H_2O. The existence of a negative complex ion is verified by data from ionic migration and ion exchange resin experiments. 11 references.

118 The Action of Hydrobromic Acid on 1-C^{14}-D-Glucose. John C. Sowden. J. Am. Chem. Soc. 71, 3568(1949) Oct.

It has been shown that in the vigorous dehydration and cleavage of D-glucose by mineral acids to formic and levulinic acids, the aldehyde carbon of the hexose becomes the carbon of the resultant formic acid. This was accomplished by an examination of the products from 1-C^{14}-D-glucose and hydrobromic acid. The levulinic acid produced was devoid of radioactivity whereas the formic acid showed quantitatively the radioactivity previously possessed by the aldehyde carbon of glucose.

119 Applications of Radioactive Chlorine to the Study of the Mechanisms of Reactions Involving Changes in the Oxidation State of Chlorine. Henry Taube and Harold Dodgen. J. Am. Chem. Soc. 71, 3330-6(1949) Oct.

By experiments using radioactive chlorine as tracer, the following observations were made: (a) The oxidation of chlorite by chlorate in acid is much slower than the disproportionation of chlorite. (b) In the reaction of chlorite with chlorine (or hypochlorous acid) to form chlorine dioxide or chlorate and chloride ion, most of the chlorine atoms in the chlorine dioxide or chlorate are derived from the chlorite. (c) In the reaction of chloride ion with chlorate ion in acid to produce chlorine and chlorine dioxide, the chlorine

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atoms in the chlorine dioxide are for the most part derived from the chlorate. (d) In the disproportionation of chlorite in acid catalyzed by chloride ion, the chlorine atoms in the chlorine dioxide are for the most part derived from the chlorite. (e) In each of the changes under (b), (c), and (d), a small but definite degree of mixing of the chlorine atoms in the products takes place. (f) The reverse reaction in the system (c) near its equilibrium composition is very slow. (g) The exchange of chlorine activity between ClO^- and ClO_2^- in base is very slow. (h) The exchange of chlorine with chlorate ion in acid at room temperature and at elevated temperatures is very slow. An unsymmetrical intermediate, $Cl\text{-}Cl<^{O}_{O}$ (or Cl-O-Cl-O), common to the systems (b), (c), and (d) is postulated.

120 The Effect on Reaction Rates Caused by the Substitution of C^{14} for C^{12}. I. The Alkaline Hydrolysis of Carboxyl-Labeled Ethyl Benzoate. William H. Stevens and Richard W. Attree. Can. J. Research 27B, 807-12(1949) Oct.

A study of the alkaline hydrolysis of C^{14} carboxyl-labeled ethyl benzoate showed that the substitution of C^{14} for C^{12} changed the rate of hydrolysis of the ester. Ester molecules containing C^{14} hydrolyzed at a slower rate than normal ester molecules, the ratio of the hydrolysis rate constants at room temperature being 0.86 ± 0.016. From these results it becomes obvious that in the case of C^{14} care must be taken in the quantitative interpretation of data obtained in tracer experiments wherever all reactions do not go essentially to completion.

121 Isotopic Exchanges of Iodine between KI and KIO_3 in Water Solutions. K. B. Zaborenko, M. B. Neĭman, and V. I. Samsonova. Doklady Akad. Nauk. S.S.S.R. 64, 541-4(1949)(in Russian).

The study of chemical exchange reactions and reaction kinetics with the aid of radioactive-isotope exchanges requires a more careful analysis of the phenomena involved than has been done in certain cases. As an example, the reaction $KI^* + KIO_3 \rightarrow KI + KI^*O_3$ is cited, which, attempted by many authors, has given negative results; this has been considered as a proof of the generally admitted impossibility of exchange between atoms of different valency. In the present authors' opinion the reaction in question is an equilibrium exchange whose speeds become measurable only on prolonged heating at high temperatures, conditions that could not be realized in the previous experiments, in all of which the short-lived isotope I^{128} (25 min) was used. By employing a mixture of long-lived iodine isotopes prepared by the method described by Khlopine et al (Doklady Akad. Nauk. S.S.S.R. 24, No. 9(1939)), many-hour long heating at temperatures up to 300°C led to positive results and the determination of the velocity constants of the exchange reaction:

Temperature (°C)	100	200	250	300
Const. (l/mol/hr)	0.27×10^{-4}	0.068	1.6	27

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122 Two Radioactive Methods for Studying Certain Gas-Metal Reactions. Clifford K. Beck. Science 110, 371-2(1949) Oct. 7.

Two methods for studying certain gas-metal reactions are presented. In one method the metal of interest is in the form of a counter tube, the same metal surface is intermittently exposed to the corrosive gas (radioactive), with periods of evacuation to inert counting gas between corrosive gas exposure. In the second method the metal of interest is in the form of wire; individual samples are removed from the exposure chamber and not reused. To obtain accurate results the metal surfaces must be smooth, clean, and uniform. Before the above methods can be used three points must be satisfied. They are: (a) the reacting gas must contain a radioactive component, (b) the product of the reaction must be a solid which adheres firmly to the metal surface and (c) the radioactive component of the gas must become a component of the solid reaction product.

123 Discussion on Crystal Growth. G. J. Szasz and C. E. Sunderlin. Office of the Assistant Naval Attache for Research, London Branch, Technical Report OANAR-17-49, nd. 12p. (NP-983).

A Faraday Society discussion on crystal growth was held at Bristol University. The contributions to the discussion were divided into four sections: (1) Theory, (2) Nucleation and Normal Growth, (3) Modified and Abnormal Growth, and (4) Mineral Synthesis and Technical Aspects.

Of particular interest were papers on the theoretical aspects of crystal growth which were presented by scientists at Bristol University, and the work of Dr. C. W. Bunn (Imperial Chemical Industries, Ltd.) on crystal growth from solution. Brief reports of extemporaneous contributions to the discussion are included.

124 Distribution of Radium between the Fused Mass and the Crystals of a Non-Isomorphic Salt. V. R. Klokman and V. G. Khlopin. Doklady Akad. Nauk S.S.S.R. 65, 33-6(1949) (in Russian).

In a previous work (Khlopin et al, Izvestiya Akad. Nauk. Otd. Khim. Nauk, No. 3 (1949)), the authors have shown that the co-precipitation of radium from the fusion of an isomorphic salt follows a law analogous to that of Berthelot-Nernst for solutions: the crystallization coefficient

$$D = \frac{x(100 - y)}{y(100 - x)}$$

is a constant; here x and $100 - x$ are, respectively, the percentage of radium in the crystalline and the fused phases, and y and $100 - y$ are the corresponding percentages of the isomorphic salt. In the present work a similar study was made for the case of a non-isomorphic salt, viz. potassium sulfate. The results showed the validity of the Berthelot-Nernst law in this case, D being equal to 0.063. The presence of small quantities of a polivalent ion in the fused mass lowers D in a considerable degree; thus, in a fusion containing 0.5 g K_2SO_4, the presence of burnt alum in a quantity equivalent to 0.3 mg of Al prevents the passage of Ra into

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the solid phase. These results show that the formation of internally adsorptive systems, known for the crystallization from solutions of non-isomorphic salts, takes place also in crystallizations from fusions.

125 The Lattice Parameters of High Purity Alpha Titanium; and the Effects of Oxygen and Nitrogen on Them. Howard T. Clark, Jr. J. Metals 1, 588-99(1949) Sept.

New values for the lattice parameters of high purity α titanium are presented. They are $a_0 = 2.9504$ A $\pm$ 0.0003 and $c_0 = 4.6833$ A $\pm$ 0.0003. The lattice constants, especially the value of c_0, are increased by the addition of small amounts of oxygen and nitrogen. Three tables and two graphs are included.

126 Reflections of X-rays at Crystals. Walter Wunderlich. Z. Physik 122, 86-97(1944) (In German).

Properties are studied of a surface which is generated when a monochromatic x-ray stream, having the shape of a conical surface of revolution, is reflected at the face of an isolated crystal. The more important plane sections of this surface, which can be used as diagram curves, are examined. The method of evaluation of the latter is discussed.

127 Some Investigations in the Crystal Chemistry of Silicates. I. Diffusion of Pb and Ra in Feldspars. Ivan Th. Rosenqvist. Acta Chem. Scand. 3, 569-83(1949).

A theoretical treatment of the diffusion of ions in crystalline silicates is followed by reports of studies on the diffusion coefficients of Pb^{++} and Ra^{++} in potash (microcline) and sodafeldspars (albite) at different temperatures. The use of radioactive tracers makes it possible to study diffusion processes with much higher accuracy than by the earlier methods. RaD (Pb^{210}) and $RaBr_2$ were used in the studies; the latter as the source of Ra^{++}. It is shown that the diffusibility depends on the crystallographic directions and that Ra^{++} diffuses more slowly in all directions in albite than in microcline pertite at the temperatures investigated. From measurement of the distribution coefficient resulting from diffusion the following results were obtained: The potash feldspar distribution coefficients for Ra and RaD, respectively, were 1.045 and 1.87; the sodium feldspar distribution coefficients for Ra and RaD, respectively, were 1.3 and 1.15. It was also shown that diffusion anisotropy seems to increase with increasing temperature.

128 The Analysis of Heavy Water of High Deuterium Oxide Content by Densimetric Methods. Rudolphe Viallard. Bull. soc. chim. France, Nos. 5-6, 265-71 (1949) May-June (in French).

A semi-micro densimetric hydrometer method for the analysis of 2-3 cc samples of materials with high deuterium oxide content is presented in detail. The formula used is

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$$x = \frac{f_t - d_t}{D_t - d_t} \cdot \frac{D_t}{f_t}$$

where x is the content by weight of D_2O in heavy water; D_t is the specific gravity of D_2O at temperature t; d_t the specific gravity of H_2O and f_t the specific gravity of the float at temperature t. The fabrication and calibration of the floats, and the procedures for the measurement of the equilibrium temperatures with a 0.001° precision are described. The question of the density of D_2O at various temperatures is discussed. The procedure is compared with the direct picnometer method, which is found to be exceedingly laborious in cases when the precision must exceed 10^{-4}.

129 A Method for the Study of the Hydrolysis of Organic Fluorine and Chlorine Compounds Submitted for Use as Non-Inflammable Hydraulic Oils. John K. Wolfe and Kenneth L. Temple. Naval Research Laboratory Report No. NRL-P-2009, Feb. 26, 1943. 9p.

In connection with fire hazards aboard ships and aircraft, considerable research is in progress to develop non-inflammable liquids for use in hydraulic as well as other naval military equipment. Halogen containing organic liquids have been suggested as non-inflammable substitutes for petroleum base oils for use in hydraulic systems. With their use the prime danger to be considered is the hydrolysis and subsequent corrosion of the metal when small amounts of water are allowed to get into the system involved. Small quantities of acidic hydrolysis and oxidation products from these non-inflammable liquids will badly corrode the metals, whereas the same quantity of acidic reaction products occurring with petroleum base oils is much less troublesome. As well as causing extensive corrosion, the hydrochloric and hydrofluoric acids liberated from these non-inflammable liquids may react with the remaining liquid and greatly accelerate its decomposition. The report proposes tests by which the oil is heated and stirred with water slightly more alkaline than sea water to obtain possible splitting of the halogen. The aqueous portion is then analyzed by very sensitive methods for the potentially corrosive materials. Apparatus for carrying out the test is described and methods of analysis are outlined. It is recommended that the test be used as a basis for rejection of submitted halogen oils from study since failure to meet this requirement signifies the presence of an impurity in the liquid or an inherent instability of the compound involved. Either of these two objectives renders such oils unfit for Naval use.

130 A Study on the Expansion of Graphite. Jacques Pierrey. Compt. rend. 223, 501-3(1946) (in French).

The thermal expansion of graphite has been studied by Nelson and Riley (Proc. Phys. Soc. (London) 57, 477(1945)), who determined, by x-ray methods, the temperature variations of the lattice elements of graphite crystals, extending these measurements up to 400°C. Since this procedure cannot be used at high temperatures, the present author employed an optical dilatometric method, measuring the distance between

the end points of test bars of agglomerated graphite crystals. The crystals (1-2 mm^2 x 10-20 μ) were agglomerated by applying the pressure in the direction either parallel or perpendicular to the axis of the test bar; if the orientation obtained was perfect, the expansion could thus be measured in directions either parallel or perpendicular to the senary axis of the crystals. The measurements covered the temperature range from 0 to 2300°C, the heating taking place in a carbon tube furnace. The following results were obtained:

Temperature intervals (°C):	0-500	500-1000	1000-1500	1500-2300
Expansion parallel to senary axis ($x10^{-6}$)	17.2	20.4	24.4	27.7
Expansion perpendicular to senary axis ($x10^{-6}$)	1.3	2.2	2.6	3.2
Ratio	13.2	9.3	9.4	8.7

The ratios are smaller than those found by Nelson and Riley; this is probably due to the imperfect orientation of crystals in the present method. The article is accompanied by a remark, made by A. Cotton, concerning the very great magnetic anisotropy of graphite.

131 Observations on the Rare Earths: Some Studies in the Absorption Spectra. Therald Moeller and John Calvin Brantley. University of Illinois Technical Report, Sept. 1, 1949. (NP-1105).

Absorption coefficients and complete absorption spectra from 2200 A to 10,000 A of many of the rare earth ions in aqueous solutions are given. The salt solutions studied are the chlorides, nitrates, acetates, and in some cases the perchlorates. An analytical procedure for estimation of the rare earth ions in chloride and perchlorate solutions by spectrophotometric methods has been established. In addition, the completeness of resolution of the bands chosen for analytical purposes has been investigated. It is shown that the chloride solutions of praseodymium, neodymium, samarium, europium, thulium, and ytterbium obey Beer's Law. Erbium perchlorate solutions also obey this law. Gadolinium salt solutions do not obey it.

It is also shown that the absorption coefficients of the chloride solutions of the cerium earths are not affected by excess chloride ions. On the other hand, the chloride solutions of the yttrium earths are affected by excess chloride ion as shown by an increase in the absorption coefficient when excess chloride is added or when the solutions stand for some time. Perchlorate solutions of the yttrium earths are not affected by excess perchlorate ion. They are, therefore, to be preferred for analytical purposes when the yttrium earths are the subject of analysis.

A study of the effects of other anions, notably the acetate, chloride, tartrate, and ethylenediamine tetracetate, on the absorption spectra of neodymium chloride and erbium perchlorate has been carried out. In studying the possible formation of complex ions in solution only one complex ion was found. The ethylenediamine tetracetate ion forms a

complex with the neodymium ion in a 1:1 ratio. Evidence was found that the acetate and tartrate ions form stable ionic aggregations in solution when there are six of these anions to one neodymium ion. The chloride ion also forms stable configurations with the erbium ion when the molar concentrations are 3:1 and 6:1.

The ability of the tartrate and ethylenediamine tetracetate ions, the former only in basic solution, to set up stable complexes in neodymium chloride solutions might be inferred from the splitting of the 5750 A band of neodymium solutions into component levels. This 5750 A band of neodymium chloride is split into six well-defined lines by a high concentration of ethylenediamine tetracetate ions (or more probably by an increase in pH) in the solution. This is the same number of lines which is found for neodymium chloride hexahydrate crystals in this region of the spectrum.

132 The Principal Magnetic Susceptibilities of Single Crystals of Rare Earth Salts at Low Temperatures. Part I. Cerium salts. A. Mookherji. Indian J. Phys. 23, 217-28(1949) May.

The principal susceptibilities of cerium salts have been measured at temperatures ranging from room temperature down to that of liquid air. The results are discussed in terms of the theory of the crystalline field. It has been found that (1) the deviation of the effective mean-square-moment of the cerous ion (from the Hund value for the free ion) can be explained on the assumption of a single suitable cubic field, which is the same at all temperatures in the range studied; (2) the mean-square-moment is determined almost wholly by the cubic part of the field, the rhombic part has very little effect on it; (3) the variation in the magnitude of the cubic field in passing from hydrated salts to anhydrous halides is found to be in the proper direction; (4) the X axis of $CeNH_4(SO_4)_2.4H_2O$ crystal rotates by about 15° as the temperature is lowered from 300°K to 85°K. 15 references. 9 tables.

133 Some Solid Solutions of the Rare Earth Sulfides in Strontium Sulfide. Harry L. Yakel, Ephraim Banks, and Roland Ward. Electrochem. Soc. J. 96, 304-9 (1949) Nov.

The nature of various solutions of rare earth sulfides in strontium sulfide has been investigated. The procedure used depended essentially upon the precision determination of the lattice constants of the solutions. La_2S_3, Ce_2S_3, Pr_2S_3, Nd_2S_3, Sm_2S_3, and Gd_2S_3 were prepared by heating the respective anhydrous chlorides in H_2S at elevated temperatures. Solutions of each were made up by intimately grinding weighed amounts of the rare earth sulfide, strontium sulfide, and a lithium fluoride flux and firing the mixtures for 1 hr in a stream of H_2S at a temperature of 1000°C. The results of the lattice constant determinations on these solutions showed that all the rare earth sulfides studied are appreciably soluble in strontium sulfide. (The anomalously high solubilities of Nd_2S_3 and Sm_2S_3 cannot, at present, be explained.) The data also indicate that the rare earth ions in solution remain in the trivalent state. It was also shown that the

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solutions are substitutional in nature, two rare earth ions replacing three strontium ions in the SrS lattice. This substitution leads to the formation of holes in the cation lattice thus making the solutions defect structures.

134 Visual Arc Spectroscopic Detection of Halogens, Rare Earths, and Other Elements by Use of Molecular Spectra. Howard W. Jaffe. Am. Mineralogist 34, 667-74(1949) Sept.-Oct.

Cl, F, Br, Y, Sc, La, B, Al, Be, Ca, and Zr may be detected in minerals by visual arc spectroscopic observation of molecular or band spectra. The versatility of the simple bunsen spectroscope is greatly enhanced through the application of molecular spectroscopy. A reference chart showing the most characteristic spectra of the visible region is included.

135 New Neptunium Compounds. Irving Sheft and Sherman Fried. AECD-2731, June 28, 1949. Decl. Nov. 1, 1949. 7p. Proposed for publication in J. Am. Chem. Soc.

Neptunium silicide ($NpSi_2$), neptunium nitride (NpN), and neptunium phosphide (Np_3P_4) have been prepared and identified by their x-ray diffraction pattern. The reaction of these compounds with water and dilute acid is described. Neptunium trichloride was prepared by reduction of neptunium tetrachloride with ammonia gas. Action of a hydrogen sulfide-carbon disulfide mixture on neptunium dioxide gave the "reduced" neptunium sesquisulfide (Np_2S_3) isomorphous with U_2S_3. Attempts to prepare interstitial compounds of neptunium with boron, carbon, selenium, and tellurium were unsuccessful.

136 The Vapor Pressure of Americium. N. D. Erway and O. C. Simpson. AECD-2733, nd. Decl. Nov. 21, 1949. 15p. Proposed for publication in J. Chem. Phys.

The vapor pressure of americium from a dilute solution in plutonium has been measured by a modification of the Knudsen effusion method (Ann. Physik, 29, 179 (1909)). This modification is made possible by the relatively short half-life and high specific activity of Am^{241}, which permit its use as a tracer. The experimental vapor pressure curve for pure americium in the temperature range 1450-1820°K is given by the equation $\log_{10}P_{mm} = 7.02 - (11{,}300)/T$. On the basis of this equation the molar heat of vaporization of americium is 51.7 kcal/mole; the normal boiling point is 2,460°C; and the molar entropy of vaporization at the normal boiling is 18.9 cal/deg. mole. The uncertainties in the initial concentrations of Am^{241} and Pu^{239} and in possible deviations from ideal solution laws may make the results in error by so much as a factor of 2 or 3.

137 The Crystal Structure of UBi. Leo Brewer, Russell K. Edwards, and David H. Templeton. AECD-2730, Aug. 31, 1949. Decl. Nov. 2, 1949. 15p. Proposed for publication in J. Am. Chem. Soc.

Samples of uranium-bismuth alloys have been prepared and investigated by means of x-ray diffraction. One of the four

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phases identified is attributed to the compound UBi. Its diffraction pattern corresponds to a simple cubic lattice with a = 3.182 A; however, since this cube is large enough for only one atom, the pattern is interpreted as being due to a sodium chloride structure with a = 6.364 A.

138 Solubility of Oxygen, Nitrogen, and Fluorine in Uranium Hexafluoride. H. A. Bernhardt, H. W. Bishop, R. H. Capps, and H. B. Weisblatt. AECD-2734, Sept. 10, 1949. Decl. Nov. 17, 1949. 15p.

The solubilities of gaseous fluorine, oxygen, and nitrogen in both solid and liquid uranium hexafluoride have been determined over a range of temperatures. At the 95% confidence limit the average mole % of fluorine dissolved in solid uranium hexafluoride in the temperature range between 50°C and the melting point is 0.058 ± 0.025 while the average mole % of fluorine dissolved in liquid uranium hexafluoride is 0.125 ± 0.020 in the temperature range between 70 and 85°C. The mole % of nitrogen and oxygen dissolved in solid uranium hexafluoride over the same temperature range as above are 0.055 ± 0.025 and 0.068 ± 0.050, respectively, while the corresponding % in the liquid are 0.093 ± 0.103 and 0.165 ± 0.031. These solubilities correspond to calculated activity coefficients for fluorine, nitrogen, and oxygen in the liquid phase of 0.24 ± 0.08, 0.47 ± 0.88, and 0.25 ± 0.07, respectively. Measurement of the equilibrium pressure of fluorine-uranium hexafluoride systems at 20-85°C revealed no evidence of compound formation.

139 Absorptiometric Determination of Uranium. A. A. Smales and E. Furby. Nature 164, 579(1949) Oct. 1.

The effect of bicarbonate in the hydrogen peroxide method for the absorptiometric determination of uranium is considered. This is one of two general effects which have not been stressed in the literature, i. e., that the light absorption of optical density for a given concentration of uranium with excess peroxide present is dependent (a) upon the final pH and (b) upon the particular alkali used (or if a mixture, upon the relative amounts). An accompanying graph shows that at 365 mμ the sensitivity of the method is some 25% greater at the higher pH values than at the pH of approximately 11 reached by Sandell's conditions (Colorimetric Determination of Traces of Metals, New York, Interscience Publishers Inc., 1944) as used by Scott (Nature 163, 768(1949)). This sensitivity was achieved with a commercial filter absorptiometer using a mercury lamp source. It was possible to overcome the effect noted by Scott, for reasonable amounts of sodium bicarbonate, or carbonate, or both, by addition of sodium hydroxide to a pH of 12.9.

140 Determination of Uranium in Ores; Modified Mercury Cathode-Cupferron Method. F. T. Rabbitts. Can. Mining J. 70, 84-6(1949) Oct.

A picture of a modified mercury cathode cell along with a wiring diagram is presented. The construction of the cell and its operation are completely described. By electrolysis with the mercury cathode in dilute acid solutions the ele-

ments having high decomposition potentials (approximately 30 elements) are removed quantitatively because they are not deposited in the mercury. Therefore, simplified procedures for determining the remaining elements may be employed utilizing less time and increasing the accuracy of the analysis. Several chemical formulas and references are included.

141 The Instability to Heat of the Uranyl Nitrate-Diethyl Ether System. M. Cheylan. Bull. soc. chim. France, Nos. 7-8, 641-5(1949) July-Aug. (in French).

The instability of uranyl nitrate in the presence of ether (the "explosive uranyl nitrate") has been explained by the formation of nitrous products, the catalytic action and the radioactivity of the uranium ion, or by the oxidizing action of the nitrate. It is shown that the ether solutions of uranyl nitrate are oxidizable without deflagration up to 85-90°; that the catalytic action and the radioactive effect of the uranium ion appear to be negligible; that the isolatable compounds of the uranyl nitrate-ether system do not contain NO_2 in the molecule; and that the compounds are stable to detonation and also are stable to heat of up to 85-90°, the temperature which provokes the deflagration of the mass with the formation of orange UO_2 and of different products of oxidation of ether, notably acetaldehyde and ethyl peroxide. It is also shown that this decomposition is due to the sole oxidizing action of a soluble nitrate which is present in the ether in strong concentrations, and that this decomposition can be demonstrated also with thorium nitrate, which excludes all specific action of the uranium ion.

142 Spectroscopic Properties of Uranium Compounds. G. H. Dieke and A. B. F. Duncan. New York, McGraw-Hill, 1949. 290p. NNES Div. III, Vol. 2.

This discussion of the uranium compounds has been divided into two parts. Part I deals with the spectroscopic properties of these compounds and includes discussions of (1) the x-ray analysis of the crystal structure of uranyl compounds, (2) experimental procedures, (3) a general treatment of the fluorescence and absorption spectra of uranyl compounds, (4) fluorescence spectra of uranyl compounds, (5) absorption spectra of uranyl compounds, (6) intensity measurements, and (7) miscellaneous uranium compounds. In Part II, the preparation of uranium compounds is considered and the following topics are discussed: (1) the synthesis of uranyl compounds; (2) the preparation of other uranium compounds; (3) problems in synthesis; and (4) growth of crystals. Various useful information is given in the form of appendixes which contain tables of wavelengths, discussions of special uranium preparations and related apparatus, and miscellaneous information on the chemistry of uranium. An 11-page chronological bibliography is included.

143 Stability of Solutions of UCl_4 in Alcohol, Acetone, and Water. C. B. Amphlett. University of Birmingham Report BI-37, May 31, 1944. 4p.

UCl_4 can be recovered from solutions in alcohol, acetone, and water by reduced pressure distillation. In all cases

the recovered products show a low percentage of uranium and dissolve more slowly and less vigorously in water than does pure UCl_4. The products from alcohol and acetone appear to have an indefinite composition and contain strongly adsorbed solvent and condensation products; in the case of acetone the tendency is to form syrups. The product from water can be crystallized from the syrup obtained on concentration and appears to be a hydrate of UCl_4. Alcohol and acetone solutions can be refluxed unchanged, but aqueous solutions undergo hydrolysis at 100°. The hydrolysis does not seem to be simple, the product forming a colloidal solution; analysis shows a low percentage of uranium compared with any of the uranium oxides, and the product contains Cl^-

144 The Structure of the Borides of Uranium. Félix Bertaut and Pierre Blum. Compt. rend. 229, 666-7 (1949) Oct. 3 (in French).

From a study of the Debye-Sherrer diagram of the microcrystalline powder of UB_{12} it appears that the lattice has a face-centered cubic structure described in detail in the article. The study of UB_4 has not yet been completed. Some details are given but the positions of the B atoms is not yet known.

145 The Structures of Uranium Metal. A. S. Wilson and R. E. Rundle. Acta Cryst. 2, 126-7(1949) Apr. (Short communication).

X-ray diagrams of β and γ uranium at high temperatures, and at room temperature, have been obtained. Beta uranium produces an x-ray diagram similar to, but even more complex than, α uranium. With the powder data available, the authors have thus far been unable to determine the structure of lattice. In view of the similarity of the low-order reflections it seems likely that the β and α structures are related. At 800°C the lattice constant for γ uranium is 3.48 kX. The lattice constant of γ uranium at room temperature has been studied as a function of molybdenum content, using a symmetrical, self-focusing, powder camera of 5 cm radius. Graphical extrapolation to pure uranium leads to a lattice constant of 3.467 ±0.005 kX and a room-temperature density of 18.89 ±0.05 g cm^{-3}, slightly less than that of α uranium at the same temperature.

146 The Use of Ether Extraction in the Determination of Uranium. T. R. Scott. Analyst 74, 486-91(1949) Sept.

The variables affecting the ether extraction of uranyl nitrate from aqueous solutions have been examined and an analytical procedure capable of wide application has been described. Extractions are carried out in solutions containing 3N nitric acid and 1M ferric nitrate, the latter being a more efficient salting-out agent than the majority of inorganic nitrates. Under these conditions 99% recovery of uranium can be achieved by three extractions using equal volumes of ether and aqueous solution, and considerable amounts of other anions can be tolerated in solution without substantial modification of the procedure.

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147 Application of Beta Ray Backscattering to Industrial Gauging. J. R. Carlin. Rubber Age (N. Y.) 66, 173-6(1949) Nov.

The principles of operation and the industrial applications of a β gauge which utilizes back-scattering are considered. The instrument was developed to make it possible to obtain the weight per unit area or thickness measurements on materials which are accessible from only one face or on materials superimposed on other substances, provided in this latter case that an atomic number difference exists between the two materials. The measurement is entirely non-destructive and no physical contact is made with the specimen, which can either be stationary or in motion. A source mount containing the β-emitting radioisotope is located outside the window of a radiation detector. The window face is thinner in structure than the other sections of the detector to permit the entrance of β particles from this one direction. If a layer of material is inserted into measuring position beneath the source and detector, some β particles will be scattered or diffusely reflected and return to enter and energize the detector. Curves are given of the detector response as a function of the thickness and of the atomic number of the scatterer.

148 Atomic Energy and Rubber. J. Eisenmann. Rev. Gen. Caoutchoue 26, 569-72(1949) (in French).

The uses of radioisotopes in the rubber industry are presented. Also discussed are the various ways in which rubber is employed in the handling of radioisotopes and in the production of atomic energy.

149 Industrial Uses of Radioactivity. L. Yaffe. Eng. J. 32, 402-7(1949) July.

The historical development of experimental nuclear physics and of the means of producing artificial radioactivity are traced briefly. A schematic diagram of a pile is shown and discussed and some of the uses of isotopes in pure research, applied research, and process control are noted.

150 A Preferentially Oil Soluble Carrier for Radiocobalt-60. J. R. White. J. Chem. Phys. 17, 1000 (1949) Oct. (Letter to the editor).

The cobaltous salt of the dodecyl ester of tetrahydrophthallic acid is shown to possess properties which render it satisfactory for use as a carrier of Co^{60} in the quantitative measurement of the location and flow of liquids through porous media or behind barriers to visibility and access. The measurement is carried out by incorporating a γ-active material in the liquid and tracing its movement with a Geiger counter or other radiation detector located externally to the system barriers. When the flowing liquid consists of mutually little soluble liquid pairs, such as water and oil, it is generally desirable that the γ-active tracer be confined to only one liquid phase. A method is given for the preparation of oil containing as much as 0.03 mc/ml of the cobaltous salt.

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151 Fields of Technical Application of X and γ Rays. E. A. W. Müller. Z. Ver. deut. Ing. 91, 173-6(1949) Apr. 15 (in German).

A list is presented (186 references) of German, American, and other works, published chiefly during the last war, on the technical applications of x and γ rays as detectors of flaws, inclusions, corrosion, assembly irregularities, fine structure variations, etc. The material is assembled into the following five main groups (with many subdivisions): welding, founding, electrical engineering, mechanical engineering, various other fields (wood, textiles, food). A short introduction points out the main tendencies in the war-time development of these techniques in Germany and in the United States.

152 Errors Made in McLeod Gauge Readings. P. Romann. Le Vide 3, 522-30(1948) Nov. (in French).

A new type of McLeod gauge is described which has been designed to minimize errors. Numerical examples are discussed and values of the constants necessary for constructing the direct reading graduated scale are given.

MINERALOGY, METALLURGY AND CERAMICS

153 Preparation of High Strength Shapes from Crystalline Boron. William W. Wellborn. AECD-2732, July 19, 1948. Decl. Oct. 26, 1949. 5p.

A small amount of boric oxide as a binder and powder metallurgy methods have been used in preparation of shapes from crystalline boron. Shapes have been produced which were 95% pure boron and had compressive strengths in excess of 50,000 psi.

154 The Production of Ceramic Ware by Slip-casting. Wayne Calderwood. AECD-2736, Oct. 20, 1945. Decl. Nov. 12, 1949. 8p. For publication in NNES.

Ceramic bodies of many sizes and shapes and of varying chemical and refractory properties were required for the study of physical properties of metals and alloys, for thermal analysis of alloys, for casting metals, and for other purposes. Many of these bodies were made by slip-casting; zirconia, beryllia, thoria, and alumina being successfully fabricated in this way. The preparation of the slip, casting of the body, removal of the cast from the mold, firing of the body, and the properties of the resultant ware are described. The formation of special shapes, such as thermocouple shields and other bodies; and the use of cotton cord as a form, to be burned out on firing, as a means of producing ware with holes or perforations, are described. In the high-temperature melting of metals and in thermal studies of composition and properties of metals and alloys, a great many crucibles, shields, and other ceramic bodies of a variety of properties are needed. Several different modes of fabrication have been used, including slip-casting. Materials such as CaO are not adaptable to the slip-casting methods because of their chemical reactivity;

however, other oxides are sufficiently unreactive with water to permit the formation of slip, in which case the method produces good, sound ware with a small amount of equipment. Slip-casting has been used at Iowa State College in the fabrication of BeO, ZrO_2, and ThO_2 ware. Ordinary methods of preparation of plaster of Paris molds were used in connection with slip-casting of these materials.

155 Deposition of Boron. H. I. Schlesinger, George W. Schaeffer, and Glen D. Barbaras. AECD-2737, Mar. 27, 1944. Decl. Nov. 14, 1949. 3p. For publication in NNES.

As a result of the development of convenient methods for the preparation of diborane (B_2H_6), it has become practical to deposit films of boron on glass and on metals by the thermal decomposition of diborane at temperatures between 500 and 600°C. If the temperature is too low, the boron deposits are likely to be contaminated with solid hydrides of boron; if the temperatures are too high, several secondary changes are likely to occur: (1) the amorphous deposit tends to become crystalline, (2) the boron coating tends to diffuse from the surface into the metal, and (3) borides may be formed. Deposits have been made on glass, aluminum, iron, chromium, silver, tantalum, molybdenum, platinum, and tungsten, as well as on the alloys—chromel, alumel, and constanan. The deposit may be made in any desired thickness up to 10 mils, but the thicker the deposit the greater is its tendency to chip off from the metal surface.

156 Induction Furnace for High-temperature Ceramic Research. P. D. Johnson. J. Am. Ceram. Soc. 316-19(1949) Oct. 1.

A vacuum induction furnace for high-temperature research is described. With the use of molybdenum units, temperatures up to 2300°C. may be obtained. A schematic diagram of the furnace, three photographs showing the furnace and auxiliary equipment, and one graph illustrating a typical run are included.

157 Some Physical Characteristics of Beryllia Slip. A. E. Williams and B. J. Gardner. Atomic Energy Research Establishment Report AERE-M/R-365, June 1949. 8p.

Experiments designed to find the relationship between pH, viscosity, and sedimentation volume for beryllia slips are reported. The slips were made using finely ground beryllia suspended in water, with hydrochloric acid as the electrolyte. The viscosity of a beryllia slip was found to increase with acidity of the slip. A decrease in the sedimentation volume of the slip was found to occur with increase in acidity. On the basis of these results a pH of 1.5 is recommended for slip casting of beryllia.

158 Age Determinations of Pegmatites in Topsham, Maine. Vincent E. Shainin. Bull. Geol. Soc. Am. 60, 1727(1949) Oct. (Short communication).

It is noted that Ahrens' (Bull. Geol. Soc. Am. 60, 217-66 (1949); NSA 2-1570) value of 200×10^5 years for the age of

lepidolite, as determined from a pegmatite by means of data on the strontium-rubidium ratio tends to confirm the value reported by Gonyer of 232×10^5 years, obtained by the lead-helium method, rather than the much higher value (600×10^6 years) obtained by Kroupa (Lane and Marble, Bull. Nat. Research Council, 57; 59(1937)).

159 Cushioning Device for Radiation Detector. Gerhard Herzog (to Texaco Development Corp., Wilmington, Delaware). Canadian Patent 460, 322, Oct. 11, 1949.

A device for preventing the production of detector currents caused by mechanical shocks during the lowering operation in logging substrata from a bore hole is described. The device consists of resilient members placed longitudinally and forming a cushion between the radiation detector and the detector housing.

160 Method of Detecting and Measuring Radiant Energy for Locating Subterranean Petroleum Deposits. Walter Armstrong. Canadian Patent 460, 655, Nov. 1, 1949.

A method for the detection of radiant energy in subterranean petroleum deposit operations is described. This method consists of shielding an ionization chamber from earthly ionizing electrical radiations by enclosing it in an insulated jacket which completely surrounds it except for a portion of the shield, through which the reception of the radiations from the petroleum deposit region is permitted. The inner surface of the ionization chamber is charged negatively electrostatically by charging an electrode in the center of the chamber positively electrostatically. The rate of change of the electrostatic charges on the chamber wall and the electrode is measured and is compared with the rate of change normally encountered, that is, without the presence of the radiations.

161 Well Logging. Frederic W. Albaugh (to Union Oil Company of California, Los Angeles, Calif.). U.S. Patent 2,463,733, Mar. 8, 1949.

A method for determining the characteristics of a well bore is presented and consists of three procedures: the natural γ-ray intensities of various strata of the well core are measured first; then the strata are bombarded with fast neutrons and simultaneously the secondary γ rays emitted from the formations are measured; finally, the strata are subjected to neutron bombardments of from 0.5-60 min or more at the rate of 5×10^8-5×10^{10} neutrons per sec and the activity returning from the rock is then tested. An α-ray source of 50-5,000 curies is used in the second procedure, the neutrons being derived from a nuclear reaction between α particles of Po^{210} and beryllium and boron metals. The composition of the substrata is determined by the third procedure through counts beginning after the termination of the irradiation.

162 Apparatus and Method of Detecting and Measuring Radiant Energy for Locating Subterranean Petroleum Deposits. Walter Armstrong. Canadian Patent 460,657, Nov. 1, 1949.

An apparatus for detecting the radiant energy emanating from subterranean petroleum deposits is described, and

consists of an ionization chamber entirely enclosed in a protective shield except for a portion used for the reception of the radiations, and fitted with a microscope extending through the opening. Two types of additional shields are described, a gaseous shield for the disintegration of a portion of the radiant energy emanating from the subterranean deposits, and a metallic shield for the shielding of the ionization chamber against earthly ionizing radiations, and ionizing radiation created in the gaseous shield; means for the measurement of the radiations are also described.

163 Apparatus and Method for Detecting and Measuring Radiant Energy for Locating Subterranean Petroleum Deposits. Walter Armstrong. Canadian Patent 460,658, Nov. 1, 1949.

An apparatus is described for the detection of ionizing radiation emanating from petroleum deposits and consists of an ionization chamber provided with electronic means for the determination of the rate of change of a positive electrostatic charge on an electrode in the chamber with the change of a similar electrostatic charge on the electrode when shielded from the ionizing radiations. The chamber is shielded by a covering between the chamber and the source of the radiations in which there is an open portion essentially impervious to earthly ionizing radiations. The inner surface of the ionization chamber is charged negatively electrostatically; and the rate of dissipation of the charge from the surface is compared with the rate under normal conditions.

164 Apparatus and Method for Detecting and Measuring Radiant Energy for Locating Subterranean Petroleum Deposits. Walter Armstrong. Canadian Patent 460,659, Nov. 1, 1949.

An apparatus is described for the detection of ionizing radiations emanating from petroleum deposits. It consists of an ionization chamber provided with a means for the determination of the rate of change of a positive electrostatic charge on the ionization electrode and a negative charge on the inner surface of the chamber and the determination of the rates of change of the charges without the presence of radiations from the petroleum deposits. The chamber is protected by a shielding device, which entirely encloses the unit except for a opening which is essentially impermeable to earthly ionizing radiations; the whole unit is movable and can be turned in any direction, so as to detect radiations emanating from a relatively small area.

165 Exploring the Bed of the Ocean. Hans Pettersson. Nature 164, 468-70(1949) Sept. 17.

A preliminary report is given of the extensive results obtained during a fifteen-month Swedish deep-sea expedition. The data taken include a continuous record of the bottom profile along a nautical course of 20,000 nautical miles and 200 long cores taken from depths between 2,000 and more than 4,000 fathoms. In addition there were obtained more than 400 oscillograms from explosions in depths between 300 and 3,500 fathoms and their echoes (taken with a special ultrasonic echograph), and approximately 4,000 samples of sea water from varying depths, some of them large volume, for uranium and radium analyses. Ten thousand temperature records by reversing thermometers or, in the surface layers, by bathythermographs, are included in the oceanographical data, which were mainly concentrated along cross sections through the equatorial current system. Observations were also made on submarine daylight, in different spectral regions, including the ultra-violet, and on the occurrence of light-scattering particles suspended in the deeper water layers. Special attention was given to the very lowest water layers down to about two fathoms from the bottom. Confirming the results previously obtained from more limited samples, it was found that the uranium content of large-volume samples of sea-water from various localities and depths is fairly constant, varying between limits of 1.0 and 1.6 μg/l. The radium content is always considerably less than the theoretical value in radioactive equilibrium with the uranium. The radium content also is found to increase with increasing depth. This deficiency in radium supports the hypothesis of a precipitation of the intervening element, ionium, (Th^{230}), to the sea bottom; this would also explain the generally high content of radium in the red clay and in radiolarian ooze.

166 The Isotopic Composition of Fossil Ice. R. V. Teĭs. Doklady Akad. Nauk. S.S.S.R. 62, 365-7(1948) (in Russian).

Vernadskiĭ (Compt. rend. 199, 694(1934)) has pointed out that in the process of melting of the great masses of ice of the glacial age, a gradual enrichment in the deuterium content should take place, due to the difference between the vapor densities of H_2O and D_2O; an investigation of fossil ices should give information on the phenomenon. The present author studied several samples of Siberian fossil ice from various localities, by using his method of combined determination of density and refraction index, described in former works (Doklady Akad. Nauk. S.S.S.R. 28, 70(1940); 32, 199(1941); 53, 533(1946)). The measurements confirmed the expected positive deuterium effect, and also showed a negative effect due to O^{18}. This impoverishment in O^{18} content of the solid phase is not clearly understood, no determinations of the melting point of H_2O^{18} having yet been made; indirectly, Gilfillan (J. Am. Chem. Soc. 56, 2201 (1934)) has found the value $-0.1 \pm 0.05°$. All these peculiarities of the Siberian fossil ice have been previously observed by the author on the névé of the high Caucasian ranges (Doklady Akad. Nauk. 28, 70(1940)).

167 New Data on the Geochemistry of Inert or Noble Gases. V. G. Khlopin and E. K. Gerling. Radium Institute, Academy of Science, USSR, May 20, 1948. 6p. (NP-928)

A new method and formula for determining the age of uranium minerals by the ratio of xenon to uranium in them has been proposed and verified experimentally. Conversely, the same formula can be used to estimate how much xenon can accumulate in the earth's crust during the geological time of its existence. A calculation shows that the quantity

of xenon formed by spontaneous uranium in the earth's crust during the geological period of its existence is considerable and amounts to about 0.5% of its total xenon content. The origin and occurrence of other noble gases (krypton, argon, helium) is discussed with particular emphasis on the radioactive and astrophysical origin of subterranean helium. The nuclear reactions of argon are briefly discussed.

168 A new Determination of the Relative Abundance of Rhenium in Nature. Harrison Brown and Edward Goldberg. Phys. Rev. 76, 1260-1(1949) Oct. 15 (Letter to the editor).

The rhenium content of five iron meteorites has been examined utilizing the neutron activation method of analysis described elsewhere (Brown, Revs. Modern Phys., to be published). It was found that the abundance of rhenium is probably at least 50 times as large as that reported by the Noddacks (Naturwissenschaften 35, 59(1930)). This indicates that the discontinuity which exists at A = 185 and A = 187 in the curve representing the relative abundances of the nuclear species as a function of mass number is the result of faulty determinations of rhenium concentrations in meteorites by previous investigators. It is also noted that the abundances of the odd nuclear species of the sequence beginning with rhenium, i.e., Re^{185}, Re^{187}, Os^{189}, Ir^{191}, Ir^{193}, Pt^{195}, and Au^{197}, increases significantly with increasing mass number.

169 Radiological Well Logging. Gerhard Herzog (to The Texas Co., New York). U.S. Patent 2,475,137, July 5, 1949.

A method of logging bore holes is described; it consists of passing a source of neutrons and γ rays through the hole and simultaneously and separately measuring the γ rays liberated by the neutron bombardment of the rock formations around the hole and the γ rays from the radiation source which were scattered by the rock formation, and then returned to the hole; by correlating these measurements with the depth of the radiation source in the hole, the configuration of the area surrounding the well hole is determined.

170 Neutron Method of Porosity Logging. William L. Russell (to Wells Surveys, Inc., Tulsa, Oklahoma). U.S. Patent 2,480,674, Aug. 30, 1949.

The primary object of this invention is to provide a means for recording graphically the variation of porosity and permeability versus depth in a well or bore-hole digging operation; this method is not influenced by the chemical nature of the rocks encountered in the area tested. The procedure consists of introducing into the bore under suitable pressure a fluid containing one or more elements differing in their known response to neutron radiation (i.e., a material with a stable nucleus) from that of the area to be tested. The fluid is forced into the porous and permeable strata surrounding the bore hole, and thereafter the quantities and locations of the fluid substance can be measured by the neutron bombardment logging technique.

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171 An Evaluation of Radioactive Isotopes in Metallurgy. C.E. Birchenall and W.O. Philbrook. Iron Age 164, 77-82(1949) Nov. 10.

A discussion of the advantages and limitations of radioactive tracers in metallurgical research and development is given. In process metallurgy, radioactive iron and calcium have been used to study reactions between molten iron and slags. In physical metallurgy, five different isotopes have been used in studies on diffusion in metals, oxidation, and scaling. Structure and segregation are being studied by exposure of photographic film to radioactive alloys. Personnel problems and precautions necessary in handling radioactive isotopes are also described.

172 Interstitial Atomic Diffusion Coefficients. C. Wert and C. Zener. Phys. Rev. 76, 1169-75(1949) Oct. 15.

An attempt is made to interpret the temperature independent factor D_0 of the previously determined diffusion coefficients of interstitial solute atoms in metals. The primary uncertainty in the value of D_0 given by the standard reaction rate theory resides in an entropy factor $\exp(\Delta S/R)$. When cognizance is taken of an additional strain in the lattice surrounding a solute atom as it passes over a potential energy divide, and of the increase in entropy associated with an increase in lattice strain energy, one can estimate a "theoretical" range within which these entropy factors should lie. All past observations except for C and N in α-Fe are consistent with this theoretical range. The D_0's for these two systems were, therefore, redetermined by more precise measurements, and are found to be an order of magnitude higher than the original values. The associated entropy factors are consistent with the theoretical range.

173 A Method of Examination of Sections of Fine Metal Powder Particles with the Electron Microscope. Laurence Delisle. J. Metals 1, 228-32(1949) Mar.

The author describes a technique employed in the study of sections of metal powder particles, less than 20 μ in diameter with the electron microscope, by the replica method. Material such as formvar or parlodion is used for a replica. Examination of tungsten powders (with the electron microscope) dispersed in the supporting film was not found satisfactory because: (1) it did not permit differentiating between single particles and aggregates, (2) it did not show the true outlines of the particles but only the projection of a whole surface, (3) no details appeared. Therefore, replicas of sections of the particles imbedded in a mounting material suitable for polishing and etching were attempted. The method proved satisfactory and has been extended to carbonyl nickel and carbonyl iron powders

174 Titanium—Its Mechanical Properties and Industrial Significance. A.S. Darling. Mech. World Eng. Record 126, 525-30(1949) Nov. 4.

The methods for producing titanium are compared and its mechanical, fatigue, high temperature and corrosion properties are discussed. Information on the fabrication of titanium and its alloys is also presented and the difficulties

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involved in machining, wire drawing, and welding of the metal are considered.

175 Titanium Metal Produced by Degussa and Osram. Joseph S. Smatko. U.S. Office of Military Government for Germany FIAT Final Report No. 798, May 15, 1946. 11p.

Investigation of the two companies disclosed that essentially three methods were employed to produce titanium metal. Degussa reduced titanium tetrachloride with sodium metal, producing a fairly good titanium metal, but contaminated by iron from the reaction vessel. The process, however, could produce a reasonable amount more cheaply than could the other processes to be described. Osram prepared purer titanium metal by two methods. One method reduced the oxide with calcium hydride, and the other thermally decomposed titanium bromide to produce a very pure metal, resembling the product reportedly made by Kroll.

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176 Formation of the Stars and Development of the Universe. Pascual Jordan. Nature 164, 637-40 (1949) Oct. 15.

In an inductive manner, the author outlines his hypothesis for the permanent creation of matter in space. This type of approach is considered more appropriate than a deductive approach, since the possibility that processes and natural laws outside our past experience may exist is acknowledged. Thus a dimensional analysis of the empirical facts is used. This method combines the experimental data to form dimensionless quantities, and compares these dimensionless numbers with regard to their order of magnitude. By taking into account the loss of gravitational energy connected with the creation of the particles it is possible to present a convincing argument for the creation of matter in space without violating the law of conservation of energy. It is noted that the material discussed has also been treated in a quantitative mathematical manner by Ludwig and Mueller (Ann. Physik 2, 76(1948)) among others. This involved a substitution of a variable "k" (in Dirac's sense) for the gravitational constant in Einstein's theory of gravitation, necessitating a fundamental generalization of the theory. For this purpose the five-dimensional (or projective) theory of relativity proved a convenient starting-point. The results obtained in this way confirm the correctness and practicability of the author's interpretation of the problem of cosmological energy.

177 On the Cosmological Problem. F. Hoyle. Monthly Notices Roy. Astron. Soc. 109, 365-71(1949).

Earlier work (Nature 163, 196(1949); Monthly Notices Roy. Astron. Soc. 108, 372(1948)) on the continuous creation of matter is generalized, and criticisms of certain aspects of this work by Bondi and Gold (Monthly Notices Roy. Astron. Soc. 108, 252(1948)) are answered. The aesthetic issues that arise in the cosmological problem are briefly discussed.

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178 A Regularizing Time Transformation in Metric Cosmology. E. Rabe. Z. Astrophys. 25, 255-60 (1948) (in German).

By means of a formal analogy between the temporal behavior of the world-curvature radius R in the pulsating spherical world model for $\lambda = 0$, $\epsilon = +1$ and free fall in an appropriately changed Schwarzschild gravitational field, a transformation of time is derived which depends on R. Instead of the absolute universal time, previously used in metrical cosmology, an expansion-dependent relative time is introduced. Among all the transformations possible formally, which depend on an integral power of R, the one found by the author is the only one which regularizes the fundamental differential equation for R, which previously was singular for $R = 0$, and which leads to a finite non-vanishing expansion velocity at that place.

179 The Relation between Gravitation and Electromagnetism, Deduced from the Equations of Codazzi. Applications to the General Electromagnetic Field of Stars. Antonio Gião. Compt. rend. 228, 742-4 (1949) Feb. 28 (in French) (See also NSA 3-1980).

A relation is derived between E and H and the internal and external metric tensors, with the aid of the equations of Codazzi. This leads to the usual relation between magnetic moment and angular momentum. It follows from this relation that stars give rise to electrostatic fields associated with their gravitational fields. This phenomenon is possibly related to the origin of cosmic rays.

180 Secular Changes in the Mass of the Sun. V. G. Fesenkov. Doklady Akad. Nauk. S.S.S.R. 64, 795-7(1949) (in Russian).

An estimate is made of the intensity of the corpuscular emissions from the sun and other stars. The calculation starts with the assumption that this intensity is proportional to the star's luminosity, and proceeds by taking into consideration (1) the known relationship between the luminosity and the mass, (2) the nuclear reactions resulting in the transmutation hydrogen → helium, as the source of the sun's radiative energy, (3) the known intensity of the latter, and (4) the present mass of the sun. A formula is obtained giving the change in the suns's relative hydrogen content since the beginning of its existence, as a function of its age and its original mass. As a result, the original mass must have been at least several times larger than the present one. This result shows the cosmological and astrophysical importance of the corpuscular emissions.

181 The Capture of Mesons. B. Bruno. Arkiv Mat. Astron. Fysik 36 A, No. 8 (1948) 44p.

Different capture processes are discussed, and the process $\mu^- + P \rightarrow N$ is re-examined, as the results of the earlier calculations on a one-particle model (Massey and Corben, Proc. Cambridge Phil. Soc. 35, 84(1939); Sakata and Tanikawa, Proc. Phys.-Math. Soc. Japan 21, 58(1939)) seem to be somewhat questionable. The calculations are based on an α-particle model for the nucleus, and the cross

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section per proton in an α particle is estimated for the case of incident slow mesons. The results indicate that, with the same strength of coupling between the mesons and the nucleons, the cross sections for pseudoscalar mesons and vector mesons are about equal, whereas in the scalar case the cross section is considerably smaller (by a factor of 60 or so). The cross section for pseudovector mesons is also possibly somewhat smaller. The calculations with scalar and pseudovector mesons seem, however, to be particularly uncertain. The cross sections obtained must be corrected for possible considerable errors. The calculations have been carried out so that the most important corrections will cause, in all probability, a reduction in the cross sections. The following sources of error, disregarding the choice of the magnitude of the force constants, are considered to have the greatest effect: (1) the result is sensitive to the choice of the radius of the α particle, as the wavelength of the emitted neutron is of nuclear dimensions and, therefore interference phenomena will play an important role; (2) the interaction between the emitted neutron and the nucleus has been neglected; and (3) the α-particle model is only approximately valid. A correction of the computed cross sections by a factor 1/100 or so is considered reasonable and the uncorrected cross section for vector mesons is about the same as that obtained by Sakata and Tanikawa. The necessary corrections suggest an explanation in the case of direct capture, at least with scalar mesons, of the results of Conversi et al (Phys. Rev. 209, 557(1947)) concerning the capture in light and heavy elements. Theoretical considerations and a closer analysis of the experimental results, however, seem to indicate that it is unlikely that the direct process is the dominating one. In the case of indirect capture the difficulties remain. As the experimental results indicate that light mesons do not normally produce stars, the process $\mu^- + P \rightarrow N + \mu^0$ (where μ^0 refers to a neutral meson) may be the dominating one. 44 references.

182 Cosmic Ray Measurements in Rockets. Gilbert J. Perlow. Sci. Monthly 69, 382-5(1949) Dec.

The merits of rocket-obtained data on cosmic rays are discussed and some of the engineering and instrumentation problems which arise are considered. In particular the difficulties involved owing to the short time-of-flight of the rocket are considered.

183 Cosmic-Ray Mesons Near Sea Level. William L. Kraushaar. Phys. Rev. 76, 1045-58(1949) Oct. 15.

The differential and integral intensities of mesons have been studied using delayed coincidence, anticoincidence, and coincidence methods. It is shown that the differential range spectrum of slow mesons is nearly flat out to 100 g cm^{-2} of air-equivalent at sea level and at Echo Lake (3240 m). The zenith angle distribution of slow mesons has been measured, and can be expressed by $\cos^{3.3}\theta$ at Ithaca and $\cos^{3.1}\theta$ at Echo Lake. Three independent measurements of the differential intensity of mesons lead to a value of $(6.0 \pm 0.15) \times 10^{-6}$ steradian^{-1} g^{-1} sec^{-1} at a range of 105 g cm^{-2} of air-equivalent at Ithaca, New York (260 m). The

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sea level electron intensity is considered, and it is concluded that this intensity is consistent with the electron-2 neutrino decay scheme for the μ meson, provided there is a source in addition to mesons contributing electrons with a very steep zenith angle distribution. 20 references.

184 Cosmic Ray Shower Theory. Francis L. Friedman. MIT Laboratory for Nuclear Science and Engineering Technical Report No. 31 (Office of Naval Research N5ori-07806 NR-026-001), Oct. 21, 1949. 30p.

Some new techniques have been developed for obtaining quantitative results on cascade showers in cosmic rays. Appropriate adjoint equations are established for the diffusion equations describing the average development of a shower. The particle to particle distribution function is shown to be the Green's function of the diffusion equations. Green's reciprocity theorem is then proved between the distribution of particles from a single incident particle and the Green's function of the adjoint diffusion equations. The track length problem is given special consideration in order to try out the methods developed. For this problem integral equations suitable for solution by iterative procedures are constructed. Some of these equations take the form of an interconnection between the solution of the track length problem when ionization loss is neglected and the solution when ionization loss is included. They are appropriate for generating the corrections due to ionization loss when the energy per particle drops toward the critical energy. The Tamm and Belenky solution (J. Physics U.S.S.R. 1, 177 (1949)) for the track length is derived by a new procedure in which the equations are not mutilated. Improvements in the approximation can be obtained by iteration, and the first corrections are investigated. When Compton effect and knock-on collisions are omitted, the Tamm and Belenky solution is an excellent approximation. It is also shown that for the case in which ionization loss varies with the particle energy, the Tamm and Belenky solution is a first approximation to the ionization rather than the track length. The adjoint method is applied to construct a variational method for the improvement of approximate solutions for the track length, and it is generalized to apply to the shower distribution functions directly. The distribution can also be determined from its spatial moments. Formulas for deriving all spatial moments from the particle track length are given. The methods introduced appear to be capable of yielding solutions of shower problems to any desired accuracy and which include all relevant physical processes. 16 references.

185 The Discovery of the Heavy Meson. O. Monecke. Mitt. Chem. Forsch. Inst. Ind. Osterreichs 3, 29-30(1949).

The developments which led to the discovery of the meson are described. Experiments are discussed in which a photographic plate with an 85% AgBr content, having a thickness of 200 μ, was used to demonstrate the existence of a heavy meson of mass 313 m_e and charge $-e$. The half-

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life of the heavy meson, as measured at an altitude of 13,700 ft, was 6×10^{-9} sec.

186 Distribution of Nuclear Disintegrations in the Neighborhood of Large Showers of Heavy Particles. A. P. Zhdanov. Doklady Akad. Nauk. S. S. S. R. 64, 657-9(1949) (in Russian).

In previous publications (Nature 143, No. 3625(1939); Phys. Rev. 65, 202(1944)) the author has described a large shower of about 100 heavy particles recorded in a thick photographic emulsion at 9000 m altitude. Another example of such powerful nuclear explosions is given here (about 80 fragments). A characteristic property of these phenomena is the large number of accompanying nuclear disintegrations of the usual kinds: stars, "showers," isolated tracks. A careful analysis of these statistics leads to the conclusion that they are probably secondary disintegrations following the large central explosion, and that they are produced by slow negative mesons or by varitrons, whose cross section for the interaction with nuclei is between 10^{-21} and 6×10^{-23} cm^2.

187 The East-West Asymmetry Shown by Isolated Tracks in Photo-Emulsions and the Existence of a Very Heavy Meson. Max Morand. Compt. rend 229, 40-2(1949) July 4 (in French).

More than 3,000 isolated tracks were recorded on plates Ilford C_2 + B and C_3 + B, placed in a vertical east-west plane, at 4,500 m altitude, geomagnetic latitude 1°S. The measurements confirmed the existence of an asymmetry observed previously in other locations (Compt. rend. 228, 1488(1949)), its decrease with the altitude, and the variation of the zenithal angle of the maximum from 40° at 1,600 m to 60° at 2,300 m, and 70° at 4,500 m. Some of the facts assembled are interpreted as due to primary protons, while others require another explanation: they may be either accounted for by local events produced by some intermediate neutral radiation, or else they may be directly due to very heavy charged mesons, of a mass approaching 900 m_e.

188 Evidence of an East-West Asymmetry in the Distribution of Isolated Tracks Due to Cosmic Rays. Max Morand. Compt. rend. 228, 1488-90 (1949) May 9 (in French).

About 400 isolated photo-emulsion tracks, attributable to high energy protons, were obtained at two points in Africa: in the Hoggar (2,300 m, lat. 22°S), and in the Belgian Congo (1,600 m, lat. 2°S). The plates were placed vertically, in the east-west plane. The results show a well-marked preponderance in the number of particles coming from the western direction, especially so in the second mentioned locality. The effect is considerably stronger than that observed in the electronic and mesonic components of the cosmic radiation. Considering the recent observations on the transparency of nuclei (Nature 160, 260(1947)); Phys. Colloid Chem. 52, 490(1948)), it is permissible to see in some of the observed tracks the end of the range of primary protons.

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189 Experimental Study of Cosmic Rays at Various Altitudes by the Method of Photographic Plates. A. P. Zhdanov and Yu. N. Podkopaev. Doklady Akad. Nauk. S. S. S. R. 64, 313-16(1949) (in Russian).

At various altitudes between 970 and 6,000 m, photographic plates were exposed to the action of cosmic rays in air, in water (mountain lakes), and under lead, the purpose being the study of the effect of altitude and other factors upon the formation of heavy particles and nuclear fissions in the emulsion. In this preliminary paper the following results are reported. It was found from the experiments in air that the absorption coefficient in air of the component generating isolated tracks of more than 10 cm air equivalent is approximately 5 atm^{-1}, and that the cross section (for O or N) is 1.2×10^{-25} cm^2; the corresponding values for the component generating nuclear disintegrations are approximately 7 atm^{-1} and 1.6×10^{-25} cm^2; it is concluded that not all of these disintegrations are generated by the hard component; both isolated tracks and stars belong mostly to protons, some are due to α particles or to heavy mesons. The exposures under water, at depths up to 5 m, furnished the mean value 0.5 m^{-1} for the absorption coefficient in water of the component generating isolated tracks exceeding 10 cm of air equivalent. The measurements under lead filters up to 9 cm thick resulted in curves showing a well marked maximum in the region of the first Rossi maximum; this proves that some of the tracks are generated by rays formed in the lead.

190 Effects of Scattering and Absorption of Mesons on Coincidence-Anticoincidence Measurements. Rogers D. Rusk and Alma Rosenbaum. Phys. Rev. 76, 1166-8(1949) Oct. 15.

Effects due to absorption and scattering of cosmic-ray mesons with respect to position and nature of various materials were studied with a coincidence-anticoincidence counter. Lead, iron, and paraffin, and combination of them, were used. The position of the material was found to account for large variations in the counting rate which could be greater or less than that with no absorber. Effects which had sometimes been previously reported by others to indicate the presence of neutral particles are shown to be largely due to the geometry and other incidental causes. There was, however, a small residual effect due to paraffin, greater than the statistical error, always in the direction which could be interpreted in terms of exchange of charge or the production of neutral rays.

191 Further Results on Neutron Production by Cosmic-Ray Particles at Sea Level. R. D. Sard, A. M. Conforto, and M. F. Crouch. Phys. Rev. 76, 1134-6 (1949) Oct. 15.

Further measurements at sea level on neutrons coincident with charged cosmic-ray particles are reported. It is shown that the coincident neutrons are neither incident from the air nor produced in the neutron detector; they are produced in the Pb in the experimental arrangement. The earlier evidence for neutrons associated with the stopping in Pb of charged particles filtered by 12.7 cm Pb is confirmed. Evidence is presented for a second effect, neutron

production in Pb in some kind of penetrating ionizing event. These neutron-penetrating particle coincidences may well be related to those discovered by Tongiorgi in penetrating showers; their bearing on the interpretation of neutron-stopped particle coincidences is discussed. With increasing thickness of the Pb filter above the Geiger-Mueller tube telescope, the frequency of the latter is essentially constant, while the frequency of the "neutron showers" increases steadily. Intensity considerations indicate that the bulk of the neutron-stopped particle coincidences are due to μ mesons stopped in the Pb; the neutron penetrating particle coincidences may well be due to incident nucleons. A very crude estimate of the average number of neutrons per stopped negative meson gives two or three; the systematic errors are so uncertain that it can only be concluded that the multiplicity is with high probability less than about five.

192 High Energy Nuclear Effects Caused by Cosmic Rays. Louis Leprince-Ringuet, Francoise Bousser, Hoang Tchang Fong, Louis Jauneau, and Daniel Morellet. Compt. rend. 229, 163-7(1949) July 18 (in French).

Nuclear stars produced by cosmic rays have been observed in special Ilford G5 emulsions in which narrow showers of tracks which are close to the minimum relativistic ionization have occurred (Brown et al, Nature 163, 47(1949)). Two stars are described which are more characteristic and were obtained in balloons at altitudes of 25 to 35 km. Each consists of more than 50 tracks, some of which are relativistic and some of which indicate the occurrence of a high degree of ionization. The stars are analyzed and it is concluded for the first star, which exhibited a high degree of concentration about the minimum ionization, that some of the relativistic tracks are caused by protons. It is also concluded that slow mesons would be only rarely observed and that some of the relativistic particles causing the tracks were either mesons or electrons. Assuming that these tracks are not electronic, the method of production of mesons is considered. It is shown that if all of the relativistic particles are mesons, it is not possible to account for the multiple production of them by a single nucleon-nucleon collision. A second possibility considered is that a first multiple production in a single act of about 15 mesons, is followed by one or two other such occurrences of lower multiplicity in the same nucleus. This scheme is referred to as "pluralo-multiple" production of mesons and is in agreement with the results of Butler and the calculations of Lewis and Oppenheimer (Phys. Rev. 73, 127 (1948)). In the case of the second star, in which the tracks exhibited much less grouping about the minimum, it is concluded that probably few, if any, of the relativistic tracks observed were caused by mesons. Instead these tracks are probably attributable to protons or light nuclear fragments.

193 A High Yield Method for the Study of Cosmic Radiation by Means of Counters. I. Description of the Apparatus. A. Fréon and R. Maze. J. phys. radium 9, 301-4(1948) Dec. (in French).

A multiple coincidence counting arrangement has been developed in which it is possible to determine which of the

counters are discharged in each case. The essential details of the apparatus, constructed for use in an airplane, are described. The results are recorded by perforation of a strip of paper.

194 A High Yield Method for the Study of Cosmic Radiation by Counters. II. Application to the Study of Local and Extended Air Showers. R. Maze and A. Fréon. J. phys. radium 10, 85-90(1949) Mar. (in French).

The apparatus described in the first part (J. phys. radium 9, 301(1948)) has been used for the study of local and extended air showers between sea level and an altitude of 7,250 m. The results obtained on the following are given: (1) rates of growth of the large and small showers as a function of the altitude; (2) diminution of the exponent of the law of repartition of the densities with increasing altitude; and, (3) the study of the effect of an air-lead transition of photons. In the case of extensive low density showers, it was observed that only three out of nine counters were discharged.

195 Hodoscopic Study of Showers of Particles Generated in Lead by Cosmic Rays in the Stratosphere. S. N. Vernov and A. N. Charakhch'an. Doklady Akad. Nauk. S. S. S. R. 62, 319-21(1948) (in Russian).

A hodoscope, to be attached to stratospheric balloons, consisted of a three-counter telescope with a one-cm Pb filter, and of nine lateral counters, all on one side of the telescope. Besides the triple coincidences in the telescope, simultaneous pulses in one or several lateral counters were recorded, with the aid of a commutator and a rotating contact. Showers generated in the lead were thus counted, and the numbers and positions of the counters involved furnished elements for a statistics of intensities and angular distributions. It was found that the percentage of showers in the total number of particles traversing the telescope grows rapidly with the altitude up to 12 km, then remains almost stationary up to 21 km. The average number of particles in a shower is about 2 or 3, this value being constant in the whole altitude range. The angular distribution at various altitudes is in agreement with the calculations on electronic showers made by Belen'kiĭ (Zhur. Eksptl. i Teoret. Fiz. 15, No. 1 and 2(1945)). The statistical approximation of the measurements is about 8-12%.

196 Investigation of the Density Spectrum of Extensive Atmospheric Showers of High Density. V. P. Zakharova and L. Kh. Eĭdus. Doklady Akad. Nauk S. S. S. R. 65, 477-9(1949) (in Russian).

All investigations on the distribution of densities p in extensive atmospheric showers agree upon an exponential relationship $N(>p) = A/p^k$, A and k depending on the altitude and the experimental set-up. Thus, Zatsepin et al (Zhur. Eksptl. i Teoret. Fiz. 17, 1125(1947)) have found, at 3860 m altitude, for the density range 3-300 particles/m^2, $k = 1.42$. However, a more careful study of their data showed a certain dependence of k on p. In the present work, high density showers up to 5,000 particles/m^2 were investigated by com-

bining the method of ratios C_3/C_6 between the numbers of triple and sextuple coincidences with the method of varying counter areas s, for a given C. This latter procedure clearly showed the increased steepness of the slope of the line log C = f (log s) in the region of high densities. The value of k obtained by both methods is 1.76 ± 0.12. Theoretically, the increase of k with growing p is in agreement with the constancy of the exponent γ in the energy spectrum of primary particles (Migdal, Zhur. Eksptl. i Teoret. Fiz. 15, 313(1945)); up to energies 10^{16}-10^{17} ev, the values of k here given will correspond to $\gamma = 1.7$ to 1.8.

197 Investigation of Genetically Related Pulses with the Aid of Proportional Counters. N. A. Dobrotin, G. M. Stashkov, and V. Yu. Tsyrlin. Doklady Akad. Nauk S. S. S. R. 65, 473-6(1949) (in Russian) (See also NSA 1-1563 and 2-1557).

In previous works (Doklady Akad. Nauk S. S. S. R. 57, 443 (1947); 61, 249 and 261(1948)) the authors described peculiar "genetically related" pulses produced by cosmic rays in proportional counters, which could not be ascribed to ordinary showers or to single slow, strongly-ionizing particles due to nuclear disintegrations. New observations, made at 3,860 m altitude, are reported here. The instrument was a telescope consisting of two groups of flat proportional counters and, between them, a group of fast counters connected with neon bulbs and forming a hodoscope; another part of the same hodoscope was a group of counters placed at 2 m from the telescope. The set-up permitted a clear discrimination between two co-existing effects, viz. extensive showers and "genetically related pulses." In the latter, the number of pulses decreases with the number of hodoscope counters involved at each pulse; the correlation coefficient between the intensities of pulses recorded by the two groups of proportional counters is zero; the spectrum of the pulse intensities i is $N(>i) = Ci^{-k}$ with $k = 2.4 \pm 0.4$. In the showers, the number of pulses increases with the number of hodoscope counters discharged at each pulse; the correlation coefficient between the two groups of proportional counters is equal to 0.36; the exponent in the spectrum of the intensities, for the case of dense showers, is $k = 1.2 \pm 0.4$.

198 On the Latitude Dependence of the Absolute Neutron Intensities in Cosmic Radiation. Luke C. L. Yuan. Phys. Rev. 76, 1267-8(1949) Oct. 15 (Letter to the editor).

Using two identical proportional counters filled with BF_3 enriched 96% in B^{10}, data were taken in a B-29 plane at 25,000 ft on the latitude dependence of slow neutron intensities in the free atmosphere. A preliminary report of the results obtained is given in the form of a curve of the counting rate as a function of the geomagnetic latitude for 21-55°N range in latitude. Data were taken both with a tin-shielded counter and with a cadmium-shielded counter. The ratio of the neutron intensities was determined as n(55°N)/n (20°N) = 2.9. This is in good agreement with the results obtained by Simpson et al (Phys. Rev. 76, 165(1949)).

From the curve given it is possible to compute the number of slow neutrons absorbed/g of air/min at any latitude.

199 On the Mass of Neutral Mesons. A. Sokolov and B. Kerimov. Doklady Akad. Nauk S. S. S. R. 64, 199-201(1949) (in Russian).

An investigation of the equilibrium conditions of a system of nucleons, limited to the consideration of only neutral mesons, leads to the conclusion that the mass of a neutral meson cannot exceed 130 m_e. This result agrees with the fact, recently discovered by Powell et al, of spontaneous decay of π mesons into μ mesons and neutral mesons of a maximum mass 115 ± 30 m_e; it also agrees with the recent observations, made by Anderson, on the disintegration of cosmic-ray mesons of the mass 200 m_e into electrons and neutral mesons whose mass cannot exceed 130 m_e. It is possible that these neutral mesons play an important part in the interactions between nucleons.

200 On the Multiple Production of Meson. S. Hayakawa. Progress Theoret. Phys. 3, 321-3(1948) July-Sept. (Letter to the editor).

Experimental data on penetrating showers and bursts in matter are analyzed to obtain information on the meson production process, particularly with respect to the interaction between mesons and nucleons in the high energy region. An expression is obtained which can be used to obtain the transition curve for hard showers.

201 On the Ratio of Positive to Negative Particles in the Vertical Cosmic-Ray Beam at Sea Level. B. G. Owen and J. G. Wilson. Proc. Phys. Soc. (London) 62 A, 601-7(1949) Oct. 1.

A method of direct momentum measurement has been used to determine the ratio of positive to negative particles in the cosmic-ray beam at sea level. Measurements on about 12,000 particles give the ratio as 1.268 ± 0.023, and it is further shown that to the statistical accuracy of the experiment there is no variation of this ratio with momentum over the momentum range 10^9-10^{10} ev/c.

202 On the Spectrum of Electrons Produced by Meson Disintegrations. G. B. Zhdanov and A. A. Khaĭdarov. Doklady Akad. Nauk S. S. S. R. 65, 287-9(1949) (in Russian).

Several determinations, with the aid of the Wilson camera, of the energy of the electrons produced by the decay of stopped mesons have been published recently; they established the existence of decay electrons of 15 to 50 Mev. For the same purpose, the present authors used the method of lagging coincidences, at 3,860 m altitude. They found that the bulk of the charged products of the disintegration of mesons of both signs are electrons; the number of light mesons, if at all present among the products, cannot exceed 25%. The energy of the main group of the electrons is certainly less than 50 Mev. The disintegration cannot be

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interpreted, as is usually done, as $\mu^{\pm} \rightarrow e^{\pm} + \nu$, where ν is a neutrino; a better scheme is $\mu^{\pm} \rightarrow e^{\pm} + \nu_1 + \nu_2$, where ν_1 and ν_2 may be neutrinos or neutral mesons.

203 The Origin of Cosmic Radiation. Edward Teller. Phys. Today 2, 6-13(1949) Aug. (See also NSA 2-1564 and 3-739).

Some investigations concerned with the origin of cosmic rays are reviewed. One possibility considered is that moving magnetic fields may appear as electrical fields of a type which could furnish the acceleration needed to produce cosmic radiation. The solar hypothesis is discussed and some of the related phenomena which have been observed by means of the coronograph are related to the aforementioned magnetohydrodynamics. It is noted that the corona of the sun furnishes sufficient magnetic agitation and a high enough temperature to account for the acceleration of cosmic ray particles.

204 Penetrating Showers Generated in Lead. N. Shostakovich and T. Asatiani. Doklady Akad. Nauk S.S.S.R. 64, 511-12(1949) (in Russian).

A preliminary report is given on measurements of penetrating showers generated in lead by cosmic rays at 3,250 m altitude. Particles, generated in a lead plate I, passed through a lead filter II below; counter groups were placed above I, between I and II, and below II, this latter group being subdivided into two groups separated by a lead partition. The table shows the numbers of quintuple coincidences per hour:

I (cm)	II = 10 cm	II = 20 cm
0	9.2 ± 0.9	3.2 ± 0.3
3	12.5 ± 1.0	5.0 ± 0.3
8	10.7 ± 1.0	6.6 ± 0.5

A curve shows the influence of the thickness of I, after deduction of the extrapolated background effect. The phenomenon has been observed at sea level by Janossi and others, who recorded a considerably weaker effect. Besides the difference in altitude, this disagreement can be ascribed to the different geometry and sensitivity of the instruments.

205 A Preliminary Directional Study of Cosmic Rays at High Altitude. I. Apparatus and Procedure. W. G. Stroud, J. Schenck, and J. R. Winckler. Phys. Rev. 76, 1005-11(1949) Oct. 15.

A preliminary study has been made of the effects of secondary particles on the measurement of the primary directional intensity at high altitudes. Geiger counter telescopes at selected zenith angles from 0-90°, utilizing Pb filters up to 17 cm, have been sent up to 100,000 ft using constant-level Pliofilm balloons. Counting rates, temperature, pressure, and azimuthal orientation were radioed to the ground by means of a 15-channel f-m telemetering system. This paper describes in detail the electronic and mechanical features of the apparatus. 12 references.

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206 A Preliminary Directional Study of Cosmic Rays at High Altitude. II. Experimental Results and Interpretation. J. R. Winckler and W. G. Stroud. Appendix by T. J. B. Shanley. Phys. Rev. 76, 1012-19(1949) Oct. 15. (See also NSA 1-1400).

The zenithal distribution of particles at high altitudes observed with counter telescopes (Phys. Rev. 76, 1005(1949)) has been compared with simple calculations concerning the multiplicity and angular divergence of secondary particles. The observations are in agreement with a sharply collimated forward type of production event, and disagree with the wide angle type of production of hard secondaries. The azimthal distributions and zenithal distributions indicate a nearly isotropic primary flux, in agreement with geomagnetic considerations at geomagnetic latitude 56°N. The effects of the atmosphere on directional asymmetry measurements at 13-g/cm^2 atmospheric depths are concluded to be small, especially if lead filters of a few cm thickness are used. The number of low energy particles is small at this depth.

207 The Production of Mesons by Electrons. I. N. Sneddon and B. F. Touschek. Proc. Roy. Soc. (London) 199A, 352-61(1949) Nov. 7. (See also NSA 2-2105).

The cross section of the production of mesons in collisions between electrons and nuclei is calculated. It is assumed that the electrons interact with the nucleons through the electromagnetic field. The results are given for the case of pseudoscalar mesons. It is found that for electrons of energy 300 Mev the cross section is 2×10^{-30} cm^2/nucleon.

208 Pulse Coincidences in Several Ionization Chambers. V. Nikolaev, S. Nikol'skiĭ, and L. Razorenov. Doklady Akad. Nauk S.S.S.R. 65, 481-3(1949) (in Russian).

At 3,860 m altitude, coincident pulses of four horizontal cylindrical ionization chambers (two chambers above two others) were recorded by means of simultaneously taken photographs of the four oscillograms. Double coincidences were counted with and without Al filters surrounding the chambers; it was concluded from the small difference between the numbers in both cases that the pulses were due to a simultaneous production of stars in two chambers; however, the nature of the genetic connection between these stars is unknown (Dobrotin et al, Doklady Akad. Nauk S.S.S.R. 57, No. 2 (1947); Lattes et al, Nature 160, 486(1947)). Quadruple coincidences were attributed to extensive atmospheric showers. The results described agree with those obtained by Bridge et al (Phys. Rev. 74, 1083 (1948)).

209 Recent Developments in Our Knowledge of Mesons. C. Powell. J. phys. radium 9, 289-300(1948) Dec. (in French).

A general review of present knowledge of mesons is given. It is shown that recent observations made using photographic emulsions can be explained by the assumption that two types of mesons exist which have masses of approximately 310 and 200 m_e. 19 references.

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210 Showers of Mesons in the Disintegrations Produced by Cosmic Rays. Charles Peyrou, Bernard d' Espagnat, and Louis Leprince-Ringuet. Compt. rend. 228, 1777-80(1949) June 8 (in French).

The presence of particles having relativistic velocities which produce showers has been observed in sensitive photographic emulsions exposed to cosmic radiation. The possibility that the particles are mesons is considered theoretically. The following assumptions are made: (1) all of the shower particles are mesons; (2) the production of these mesons has been multiplied and they have been produced in a single nucleon-nucleon interaction; and (3) all of the mesons have been produced with the same energy in the reference system. An expression is obtained for the primary energy which has created a given shower as a function of the number of mesons produced and the angular spread of the shower. The theoretical calculations thus made are discussed in a general fashion.

211 Some Properties of Nuclear Explosions in the Cosmic Radiation. A. Lovati, A. Mura, G. Salvini, and G. Tagliaferri. Nuovo cimento 6, 207-16(1949) May (in Italian) (See also NSA 3-975 and 3-2208).

Nuclear explosions in cosmic rays were studied at 3,500 m altitude with the aid of counters and a Wilson chamber. The explosions show the simultaneous presence of strongly ionizing and penetrating particles, the latter being capable of producing successions of other nuclear explosions. The penetrating particles do not show any diffusion phenomena that are not due to Coulomb interactions. The mean cross section for the production of successive nuclear explosions in lead is about 10^{-24} cm^2, corresponding to a mean free path of about 330 g/cm^2. It follows from these results that the penetrating particles of the nuclear explosions are mainly protons or π mesons, rather than μ mesons.

212 Specific Ionization of Extensive Shower Particles. J. R. Prescott. Nature 164, 756(1949) Oct. 29 (Letter to the editor).

It is noted that there is lack of agreement among various investigators as to the value to be used for the specific ionization of shower particles in order to convert the number of ions collected by the chamber to the number of particles passing through the chamber; the values in the literature range from 50-100 ion pairs/cm for air and many are in the vicinity of 85 ion pairs/cm for argon. The following table has been made showing the calculated probable ionization for ionization chambers as a percentage of the total ionization for electrons of 100 Mev. The calculations were based on the assumption that ionization from secondaries of all energies less than η ev is completely collected, where η is the average upper limit to the energy of secondaries that expend all their energy in producing ions in the chamber.

η (ev)	Percentage total ionization	η (ev)	Percentage total ionization
10^4	74	2×10^5	83.3
2×10^4	76.3	5×10^5	86
5×10^4	79	10^6	88
10^5	81		

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213 Star Production by Negative μ-Mesons in a Silver Chloride Crystal. H. G. Voorhies and J. C. Street. Phys. Rev. 76, 1100-5(1949) Oct. 15.

A silver chloride crystal has been used to detect μ mesons which stop in the crystal or in some brass immediately below it. It is found that such mesons and their decay electrons produce pulses well above noise and with rise times of 0.2 to 0.35 μ sec. On the basis of 79 decay events, the meson mean life is found to be 1.9 ± 0.3 μ sec. By comparing the pulse height distribution for stopped mesons with the distribution of the hard cosmic-ray component, it is shown that the crystal response is proportional to energy loss for slow, heavily ionizing particles. During an experimental run 263 mesons were stopped. Forty were observed to decay, and it is calculated that 78 were negative mesons which stopped in the crystal. It is first shown that, in general, nuclear capture of negative μ mesons does not result in the production of stars in which the charged particles carry, on the average, half the meson rest energy. Further analysis shows that, if stars are produced, the average energy of the charged particles is but a very few Mev, probably less than 3 Mev. Five large pulses associated with stopped particles might be interpreted as star pulses, but some of these may be due to stopped protons.

214 Studies on the Structure of Extensive Atmospheric Showers. G. Ya. Artyukhov and L. Kh. Eĭdus. Doklady Akad. Nauk S. S. S. R. 65, 629-31(1949) (in Russian).

In the light of recent investigations, the extensive atmospheric showers cannot be considered as mere cascades of electrons and photons; the part played by heavy penetrating and strongly ionizing particles in the generation and further history of these showers is being increasingly emphasized. However, the experiment of two ionization chambers (Razorenov et al, Doklady Akad. Nauk S. S. S. R. 60, 1531(1948)) recording, as a rule, pulses of unequal intensity, can be interpreted not only as a proof of the presence of heavy particles, but also as an indication of some narrow dense beams of relativistic particles present in the general structure of an extensive shower of lesser density. In order to decide between the two possibilities, the authors measured coincidences C_6 and C_{12} in two groups of six counters radially arranged. By using brass filters and by varying the distance between the two counter groups, the conclusion was reached that the presence of narrow showers alone cannot account for the inequality of pulses in two ionization chambers placed in an extensive atmospheric shower.

215 Theory of the Negative Correlation between the 27-day Period Variation of the Cosmic Radiation and the Ca-flocculi Characteristic Numbers. E. G. Von Roka. Naturwissenschaften 36, 24-5(1949) (in German)(Brief note).

A theory is given of the negative correlation between the 27-day periodic variation of the cosmic radiation and the Ca-flocculi characteristic numbers. The 27-day variation of cosmic radiation is interpreted as a temperature effect in the upper half of the ozone layer, caused by a variation of the solar ultraviolet radiation. Detailed calculations indicate that a temperature variation of approximately 20°C

at an altitude of 40 km is sufficient to account for the observed variations. Furthermore, it follows that the variations would be small for mesons of very low and very high energy, the maximum occurring at an intermediate energy. This is borne out by experimental evidence.

216 Two kinds of Very High Energy Cosmic-ray Stars. L. Leprince-Ringuet, F. Bousser, Hoang-Tchang-Fong, L. Jauneau, and D. Morellet. Phys. Rev. 76, 1273-4(1949) Oct. 15 (Letter to the editor).

Two very characteristic nuclear cosmic-ray stars obtained at high altitudes (about 100,000 feet) with Ilford G5 emulsions are described. Both stars have more than 50 prongs, and the energy involved is greater than 12 Bev. In one case 27 ionizing prongs, corresponding to the usual type of nuclear fragments (protons, α particles, etc.), and 27 relativistic prongs were observed. It is suggested that the relativistic particles are a mixture of mesons and energetic protons, and hypotheses to explain the events involved are advanced. In the second case a heavy primary nucleus produced a 51-pronged star with 17 relativistic prongs which are not too well collimated. The star, it is suggested, is interpreted as the result of the total disintegrations of the incident heavy particle and of the struck silver nucleus, and few, if any, mesons are produced.

217 An Electronic Pressure-Sensitive Transducer. G. Day. J. Sci. Instruments 26, 327-9(1949) Oct.

A brief description is given of an electronic pressure-sensitive transducer in which the applied pressure varies the interelectrode spacing of a double-diode tube working under space-charge limited conditions. The resultant change in current is indicated as the out-of-balance voltage of a bridge circuit in which the diode forms two of the arms. Although primarily designed to give an electrical output as a function of aircraft height the device is readily adaptable for other applications.

218 An Electrometer Amplifier. V. J. Caldecourt. Rev. Sci. Instruments 20, 748(1949) Oct. (Laboratory and shop note).

A circuit utilizing the 12BE6 as an electrometer tube is shown which can be used to secure greater stability than that provided by Anker's circuit (Electronics, 138(1947) June). The d-c amplifier in operation shows a grid current of 10^{-13} amp and a noise level of less than 0.1 mv as recorded by a Speedomax A. The gain of the d-c amplifier without feedback is about 1000 and a baseline drift of 1 to 2 mv per day is average. The unit is operated 24 hr per day and is used in conjunction with a mass spectrometer.

219 Improved Multivibrator Quenching Circuit. C. V. Robinson. Rev. Sci. Instruments 20, 750-1(1949) Oct. (Laboratory and shop note).

A circuit is diagrammed and discussed which has a good multivibrator action, i.e., produces a quenching pulse whose size and duration are independent of the counter pulse, and which also permits grounding of the counter cylinder. The latter feature, not possessed by the original multivibrator circuit of Getting (Phys. Rev. 53, 103(1938)) or by the improved Maier-Leibnitz circuit (Rev. Sci. Instruments 19, 500(1948)), is necessary in the use of metal-walled counters for biological experiments in vivo.

220 Investigation of the Utility of an Electronic Analog Computer in Engineering Problems. D. W. Hagelbarger, C. E. Howe, and R. M. Howe. University of Michigan Report No. UMM-28, Apr. 1, 1949. 213p. (NP-1125).

This report gives the results of a study of an electronic analog computer as a laboratory research tool. The study was undertaken not for a particular problem but rather to investigate the applicability of the computer to applied research. An attempt is made to give enough data on methods of setting up problems and introducing end conditions, accuracy, stability, time required for solutions, and other advantages and limitations of this type computer, to enable an experimenter faced with a particular problem to make a critical comparison of this method with others which are available. The approach is that of a text book rather than a hand book; and it is believed that the report will not only give an understanding of the principles of an electric analog computer, but also enable an engineer to design and put into operation a computer, with the minimum number of pitfalls. The report may be divided roughly into four divisions as follows: introduction and components of computer (chapters 1 and 2); differential equations with constant coefficients (chapter 3, 4, and 5); differential equations with variable coefficients (chapter 6, 7, 8, and 9); study of a servomechanism (chapter 10, 11, and 12). 19 references.

221 An Isotope Calculator. W. S. Eastwood. Atomic Energy Research Establishment Report AERE I/R-333, Apr. 1949. 6p.

The report describes a calculator, developed by the Harwell Isotope Division, for estimating the activity induced in isotopes under neutron bombardment.

222 A Miniature Portable Cathode-Ray Oscillograph Recorder. Carlton F. Johnson. Instruments 22, 800-1(1949) Sept.

A portable cathode-ray oscillograph recorder has been constructed with the smallest possible dimensions consistent with its conditions of use. The instrument consists of a 1-in. CRO tube (RCA-913) and a readily removable paper drive mechanism, both enclosed in a light-tight sheet metal box 2 in. × 2.5 in. × 5 in. The box is fabricated of light gauge sheet steel with welded seams. Construction details and a schematic diagram are given.

223 Notices on Proposed Magnetic Lenses of Toroidal Type. J. I. Horváth. Experientia 5, 112-14(1949) Mar. 15 (Brief report).

The theoretical calculations relating to the design of a toroidal magnetic lens, to be used in focusing a beam of electrons of like energies originating from a point-like source, are given. The new form of toroidal magnetic β lens is designed so that the profile of the toroidal magnet-

ic field faces the preparation, surrounding it hemispherically, and the profile toward the collecting mechanism is then determined so that the electron beam is focused by the magnetic field of the lens.

224 Primary Investigation of Literature Dealing with the Measurement of Excessively High Temperatures. Hal W. Maynor. NEPA-745, Aug. 27, 1948. 12p.

This report summarizes current information from the literature and includes 33 references.

225 Use of Radio-elements in the Study of the Behavior of Alkali-earth Metals in Oxide Cathodes. Jacqueline Beydon, Lucien Beaudoin, Jean Challansonnet, and Jean Debiesse. Compt. rend. 229, 353-4(1949) Aug. 1 (in French).

Certain electronic defects in oxide cathode tubes are attributable to the volatilization of barium and its condensation on the electrodes and other tube parts. Recent chemical studies (Nature 163, 572(1949); No. 4, 145(1949)) were made in which the free barium deposited was found to be of the order of a microgram. In order to obtain more precise and general results a study has been made of the volatilization of the oxides covering the cathodes by incorporating the radioelements barium and strontium in these oxides and by measuring the activity (determined with a Geiger-Mueller counter) of the different electrodes following different degrees of usage of the tubes studied (EL3). The radioactive isotopes Ba^{140}, Sr^{90}, and Sr^{89}, used as indicators, were in equilibrium with their products. All three are β emitters and were obtained from the slow neutron fission of uranium. The results obtained varied considerably from tube to tube; data on a typical tube are given.

226 Isotopes—Their Distribution and Use. Paul C. Aebersold. Sci. Monthly 69, 349-59(1949) Dec.

The rapid growth and development of the isotope distribution program is described. Quantitative data are given which permit a comparison of the total number of shipments of radioisotopes for use in the various fields of application. Data are also given on the comparative number of shipments for the various states as well as the number of foreign shipments which have been made to the various countries. Applications of radioisotopes in several fields, i.e., biology and medicine, plant physiology and agriculture, and industry are noted briefly.

227 The Dependence of the Thermal Diffusion Factor on Temperature. K. E. Grew. Proc. Phys. Soc. (London) 62A, 655-61(1949) Oct. 1.

The thermal diffusion factor for isotopic mixtures has been calculated from values of the collision integrals given by Hirschfelder et al (J. Chem. Phys. 16, 968(1948)) which refer to molecules exerting an inverse 13th power repulsion with an inverse 7th power attraction—the (13,7) model. The theoretical results are compared with experimental ones for the inert gas mixtures previously considered by Grew (Proc. Roy. Soc. (London) 189A, 402(1947)) in relation to the (9,5) model. The agreement is, as expected, better than for the (9,5) model. Experimental results for hydrogen-helium mixtures are also given; the behavior of these mixtures is exceptional in that the thermal diffusion factor appears to be independent of temperature over the range 12-600°K.

228 Engineering Developments in the Gaseous Diffusion Process. Manson Benedict and Clarke Williams, Eds. New York, McGraw-Hill, 1949. 129p. NNES Div. II, Vol. 16.

This collection of articles by various authors on engineering techniques for gaseous diffusion processes has been divided into four main sections. In Part I, special plant instruments and devices are considered and articles on the recording mass spectrometer, the use of ionization chambers to detect traces of radioactive gases, and magnetic gear for torque transfer in closed systems are included. The problems of vacuum engineering are treated in Part II and the use of the mass spectrometer for leak detection and other new developments in high-vacuum apparatus and techniques are discussed. Parts III and IV are concerned with the development of heat transfer equipment and the absorption of UF_6 and fluorine, respectively.

229 The Mechanism of a Physical Method for the Separation of Nuclear Isomers. A. S. Karamyan. Doklady Akad. Nauk. S. S. S. R. 64, 491-4(1949) (in Russian) (See also NSA 3-1937).

In previous publications (Doklady Akad. Nauk. S. S. S. R. 55, No. 7(1947); 58, No. 4(1947)) the author, in collaboration with Rusinov, has described a method of enrichment of nuclear isomers: by irradiating C_2H_5Br with neutrons, free recoil Br^{80*} atoms are formed, which produce the bromination of C_2H_5Br into $C_2H_4Br_2$; the internal conversion of Br^{80*} into Br^{80} causes another release of recoil atoms, viz. Br^{80} from $C_2H_4Br_2$, which enrich the liquid with this isomer of radioactive bromine, so that by the subsequent electrolysis a correspondingly enriched deposit upon a silver electrode can be obtained. In the present work experiments (fractional distillations) are described, clarifying several points of the process. The parts played by the isotopes Br^{80}, Br^{80*}, and Br^{82} are more closely followed, and it is found that the metastable isomers are present both in C_2H_5Br and $C_2H_4Br_2$.

230 The Thermal Separation of Gases at High Pressures. E. W. Becker and A. Schulzeff. Naturwissenschaften 35, 218-19(1948) (in German) (Brief note).

The thermal separation of gas mixtures was measured at high pressures (1-80 atm) by means of a Clusius-Dickel separation column for various gas pairs (H_2/Co_2, H_2/N_2, N_2/Co_2, N_2/NH_3). The effect was found to increase markedly with pressure, which is interpreted by the authors as the result of an additional separation effect independent of thermal diffusion.

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231 The Effect of Space Charge on the Focusing Properties of a 180° Mass Spectrometer. Charles F. Robinson. Rev. Sci. Instruments 20, 745(1949) Oct. (Laboratory and shop note).

An expression is obtained which indicates that in situations in which the ions of a mass spectrometer resolve themselves into a single beam, the first-order effect of space charge is not a widening of the beam at the focus, but a shift of the position at which this focus occurs. A diagram of the quantities involved in this effect is given and practical values substituted for the various parameters to give some idea of the orders of magnitude involved. The author concludes from his results that proper allowance for the shift in focal position which results from high space charge will result, in many cases, in a definite improvement in resolution.

232 Focusing Properties and Resolving Power of a Magnetic Field Limited by Parallel Planes. René Vauthier. Compt. rend. 229, 181-3(1949) July 18 (in French).

Calculations are made on the focusing properties of a magnetic field limited by parallel planes and the suitability of such a field for mass spectrometry is noted. The apparatus described would make it possible to produce the focusing by a simple adjustment of the potential applied to the lens.

233 Improved Magnetic Focusing of Charged Particles. H. Hintenberger. Rev. Sci. Instruments 20, 748-50 (1949) Oct. (Laboratory and shop note).

Reference is made to Kerwin's recent article (Rev. Sci. Instruments 20, 36(1949)) concerned with a theory of magnetic focusing of charged particles in which a formula for the shape of a uniform magnetic field is deduced (Smythe et al, Phys. Rev. 45, 724(1934)) giving perfect focusing of an ion beam of wide divergence. Several special cases are discussed of second-order focusing in a uniform magnetic field whose edges are in the shape of straight lines or circles. It is noted that about a year earlier nearly the same considerations were presented by the author (Z. Naturforsch. 3a, 125, 669(1948)). It is shown that all cases second-order focusing hitherto published are special cases of second-order focusing condition previously noted by the author. Hence, second-order focusing may be applied advantageously in high intensity mass spectroscopy.

234 Ion Optics and Mass Spectrometry. W. Walcher. Nucleonics 5, 42-51(1949) Oct.

It is noted that the mass spectrometer is an optical instrument, similar in many respects to an optical spectrometer; hence, the particle trajectories in electric and magnetic fields can be calculated by the same well-known formulas used in computing light paths in a cylindrical lens. The similarity is noted by means of a discussion of the following: (1) the optical constants of magnetic sector fields; (2) the dispersion of a magnetic sector field; (3) double-focusing mass spectrographs; (4) the effect of stray fields; (5) the space-charge effect; and (6) aberrations of the second order. 10 references, 10 figures.

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235 Mass Spectra Obtained by Time-of-Flight Method. R. Keller. Helv. Phys. Acta 22, 386-8(1949) (in French).

An arrangement is described by means of which mass spectra can be determined by measuring the time taken by the particles to cover a given distance. The ions are emitted in bursts—short compared to their time of flight, accelerated by a potential, and detected by a Faraday cage, where they arrive at a time depending on their mass. The collected ionic current is amplified and fed into an oscilloscope, on which the entire mass spectrum can instantaneously be seen. Some experimental results are given for various kinds of ions.

236 Mass Spectrometry and Spectrography. Etienne Roth. J. phys. radium 10, 17D-27D (1949) Apr. (in French) (See also NSA 3-140).

This is a continuation of an earlier paper (J. phys. radium 10, 14D-16D (1949); NSA 3-140). A bibliography on mass spectrometry and mass spectrography is given which has been divided into the following subdivisions: (1) general references; (2) theory of focusing by electrostatic and magnetic apparatus; (3) recent equipment; (4) ion sources; (5) electronic apparatus; (6) various factors influencing the functioning of mass spectrometers; (7) mass measurement interpretation from mass spectra; (8) measurements of the abundances of isotopes; (9) study of isotopic changes using isotopes as tracers and in analysis; (10) separation of isotopes; (11) chemical analysis; (12) study of the reactions caused by electronic collision; (13) study of transitory phenomena; (14) study of the radioactive elements and of nuclear phenomena; (15) vacuum techniques; and (16) American patents. In most cases a brief description is given of the article.

237 The Mass Spectrum of Monoisotopic $B_2^{10}H_6$. Francis J. Norton. J. Am. Chem. Soc. 71, 3488-91(1949) Oct.

The molecular fragmentation patterns of $B_2^{10}H_6$ (containing 96% of the B^{10} isotope) and of normal B_2H_6 under electron impact with 70-v electrons have been compared by means of mass spectrometer data as recorded in the form of positive ion current at each mass.

238 Mass Spectrometry. Harold W. Washburn (to Consolidated Engineering Corp., Pasedena, Calif.). U.S. Patent 2,472,870, June 14, 1949.

This invention provides improvements in the methods of and the apparatus for mass spectroscopy; the mass spectrometer described is valuable for use in both qualitative and quantitative analysis. The author has found that by employing the voltage necessary to force the ions through the collimating slits and apertures in a direction transverse to the axis of the apertures, increased spectra intensity and stability can be produced. In spectrometers having ion slits in cross section, undesirable spreading of the ion beam may be overcome by placing an extra electrode in the space between at least the first and second electrodes containing focussing slits; other auxiliary focussing and guid-

ing electrodes in subsequent slit spaces may be used; other improvements are also mentioned.

239 The Eigenvalue Problem for Ordinary Differential Equations of the Second Order and Heisenberg's Theory of S-Matrices. Kunihiko Kodaira. Am. J. Math. 71, 921-45(1949) Oct.

The results on the theory of expansion of arbitrary functions in terms of the eigenfunctions of a differential operator of the second order, recently treated by Titchmarsh (Eigenfunction expansions associated with second-order differential equations, Oxford, 1946), by means of the calculus of residues, are proved again using the general theory of linear operators in Hilbert space. Then, by applying the aforementioned operators to equations of the Schroedinger type, it is shown that a theorem of Heisenberg (Z. Physik 120, 513; 673(1943)) concerning the S-matrix can be founded on these results. 21 references.

240 The Absorption of Microwaves by Gases at High Pressure. I. R. Weingarten. Columbia University, May 1, 1948. 57p. (NP-963).

A new improved apparatus, based on the untuned cavity method, has been designed and constructed for the measurement of line breadth and absorption coefficients in the microwave region from 0.5 to 5 cm wavelength. With this apparatus the ringing time method was successfully used for the first time.

The basic development making this a new equipment is the application of fine wire bolometers to the measurement of the transients occurring when a microwave pulse is fed into an untuned cavity. A mathematical analysis of this detector was developed, including a new general treatment of the transient response of bolometers. An analysis is also presented of the distortions that may occur in the observation of bolometer transients. Lamb's window formula was verified by making absolute measurements of the loss through various sized windows. These were made for two different cavities using the ringing time method. These measurements also confirmed the bolometer analysis presented here.

The absorption spectrum of NH_3 has been measured at pressures from 10 cm to 538 cm Hg, over the wavelength range of 0.86 to 3.2 cm. The line shape has been found to agree with the Van Vleck and Weiskopf formula to 383 cm Hg, but the resonant frequency of the inversion shifts to lower frequencies as the pressure is increased. The line width, which is proportional to the pressure below 10 cm Hg, has been found to remain essentially constant between 76 and 228 cm Hg.

241 Modulation, Generation, and Frequency Multiplication of Microwave Oscillations by a Spiral Beam of Electrons. I. F. K. Willenbrock and S. P. Cooke. Office of Naval Research Technical Report No. 79, June 1, 1949. 48p. (NP-1106).

This report includes a theoretical study of the use of a spiraling beam of electrons in the modulation, generation, and frequency multiplication of microwave oscillations. The interaction between the electromagnetic field in a cavity and an electron beam projected along the axis of the cavity is examined. The particular cavity considered is of the cylindrical TE_{11n_z} type in a steady axial magnetic field. If the cavity is excited in a linearly polarized mode, the electromagnetic field will drive the electrons in a helical trajectory with an expanding radius, and the electrons will excite and transfer energy to a degenerate mode oriented spatially at right angles to the driving field. In the driving plane of polarization (both planes of polarization if the cavity is excited in a circularly polarized mode), the electron beam will excite a field in phase opposition to the driving field in a manner analogous to the counter emf in an electromechanical generator. The converse case of a TE_{11n_z} cavity excited by a spiral beam of electrons is also considered. The change of the effective Q of the cavity as the result of powder transfer to the electron beam is discussed. With the methods of analysis developed, it is possible to examine the feasibility of modulation, generation, and frequency multiplication. Several methods are suggested.

242 The Neutron-Proton Interaction. Richard S. Christian and Edward W. Hart. AECU-392 (UCRL-384), June 29, 1949. 40p.

This document has been issued in a revised edition. The revised edition has been assigned the number AECU-606 and an abstract will appear in the next issue of NSA.

243 The Effect of Holes in a Reacting Material on the Passage of Neutrons. D. J. Behrens. Proc. Phys. Soc. (London) 62A, 607-16(1949) Oct. 1.

The increase in the migration length of neutrons in a reactor caused by the presence of holes in the reactor is considered. The migration length M of neutrons in a system is defined so that $6M^2$ is the mean square distance traveled by a neutron in the whole course of its life. This includes the time spent while the neutron is slowing down from its initial energy and the time spent while diffusing as a thermal neutron until it is finally absorbed. It is shown how this effect can be evaluated in terms of a simple geometric function of the shape of the holes, and it is found that, in addition to a variation as the inverse overall density of the material in the reactor, the migration length also contains a term which depends upon the size and shape of each hole. When the hydraulic radius of the hole becomes comparable to the mean free path of neutrons in the reactor material, this last term becomes dominant, and it is, therefore, desirable that all holes should be kept as small as possible. Holes which are totally enclosed, or which contain a unidirectional infinity (cylinders) all give results of the same order of magnitude, but anything in the nature of a two-dimensional plane gash leads to a theoretically infinite increase in the migration length, and hence to a serious escape of spare neutrons. The cases both of holes of regular shape and of the interstices between a random arrangement of regular-shaped solid bodies have been treated.

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244 A Method for the Determination of the Absolute Intensity of a Ra-Be Source of Neutrons. F. Alder and P. Huber. Helv. Phys. Acta 22, 368-71(1949) Aug. (in German).

A method is described for the determination of the absolute intensity of a neutron source, being a modification of the procedure of Gamertsfeld and Goldhaber (Phys. Rev. 69, 368(1946)). A solution of $MnSO_4$, used as a moderator, fills a spheric container in the center of which is placed the Ra-Be source; the activity of the stirred solution gives the relative number of neutrons absorbed; by taking this measurement at two different concentrations of the solution, the absolute number of neutrons is obtained. It was found that a 1 mc Ra-Be source emits 6.300 ± 7.5% neutrons/sec, a result which agrees with those obtained by some of the other methods.

245 On the Magnetic Moment of the Proton and the Neutron. P. Urban. Sitzber. Akad. Wiss. Wien, Math. naturw. Klasse, Abt. IIa, 156, 287-98(1948) (in German).

Using an expansion of the field in spherical waves and a cut-off at high moments, the magnetic moments have been calculated for a vector magnetic field. If the interaction constant used is that given by Kemmer, the correct moment is obtained for a meson mass of approximately 150 m_e.

246 On Magneto Optics of Neutrons and Some Related Phenomena. Otto Halpern. Phys. Rev. 76, 1130-3 (1949) Oct. 15.

Formulas are derived describing the phenomenon of total reflection of neutrons by a ferromagnet as a function of the state of magnetization. It is shown how experiments of this kind can give information concerning the magnetic interaction between neutrons and atomic magnetic moments. A method to obtain well-polarized neutron beams with an intensity loss of only 50% of the primary beam is outlined. The effect of pure magnetic scattering and its influence on the transmission effect is discussed; an experimental arrangement for its observation is described. The significance of the approach to saturation in the single transmission effect is discussed in connection with the saturation theory of ferromagnets. Remarks are made concerning the possibility of detecting wall effects of magnetic domains through depolarization of neutron beams.

247 On a Method of Calculating the Density of Neutrons Emitted from a Point Source in an Infinite Medium. Gunnar Holte. Arkiv Mat. Astron. Fysik 35 A, No. 36 (1948) 9p. (See also NSA 2-178).

The method leading to the formula previously deduced in the literature, for the neutron density of neutrons emitted monochromatically from a point source and slowed down by elastic collisions with the atoms of an infinite moderator, is developed systematically and extended to higher approximations, and the convergence of the procedure is investigated. The formula as previously obtained (Marshak, Rev. Mod. Phys. 19, 185(1947)) is valid for constant mean free path, small distances, and small neutron energies. A formula for variable mean free path is then deduced and an earlier paper by the author is supplemented (Arkiv Mat. Astron. Fysik 35 A, No. 2 (1947)).

248 Photo-Neutron Sources. A. Wattenberg. National Research Council Preliminary Report No. 6, July 1949. 16p. (NP-1100).

A photon falling upon a nucleus can cause the ejection of a neutron if the energy of the photon is greater than the energy with which the neutron is bound in the nucleus. The most useful sources of photons are radioactive elements, which emit gamma rays whose energies are always less than 4 Mev. In most nuclei, the binding energy of the neutron is from 6 to 10 Mev. There are only 2 known nuclei with binding energies below 4 Mev, Be^9 and D. Consequently, the photo-neutron sources which have been employed to date have used either beryllium or deuterium. The main advantage of photo-neutron sources is that the emitted neutrons are monoenergetic. The chief disadvantages are the low yields of neutrons from such sources and the difficulties which are associated with the presence of high intensity γ radiation. This report presents some general and theoretical considerations including a discussion of the energy equation for the photo-neutron reaction, γ-ray emitters, neutron energies from different sources, yields of photo-neutrons, and some considerations in the manufacture of and physical characteristics of neutron sources. 52 references.

249 Preparation and Properties of a Reproducible Neutron Standard. E. Bretscher, G. B. Cook, G. R. Martin, and D. H. Wilkinson. Proc. Roy. Soc. (London) 196A, 436-43(1949) Apr. 7.

Radium beryllium fluoride ($RaBeF_4$) is proposed as a new form of Ra-α-Be neutron source, for adoption as a standard. Three such sources have been prepared and calibrated; they give a neutron yield which is proportional to the radium content to within ½%. Details are given of the techniques used in the preparation and standardization of these sources; probable errors in the calibration are discussed. 10 references.

250 Scattering of Polarized Neutrons by Protons. A. B. Bhatia. Nature 164, 662(1949) Oct. 15 (Letter to the editor).

It is noted that the attempt to obtain the neutron-proton interaction potential empirically from the scattering cross section is hindered by the splitting into singlet and triplet states which makes the determination of the phase shifts from a knowledge of $d\sigma(\theta)$ alone impossible ($d\sigma$ is the differential scattering cross section given as a function of θ, the angle of scattering). This difficulty can be overcome by utilizing an additional property, namely, the partial depolarization of a polarized beam of neutrons on scattering by an unpolarized proton gas. Detection of the azimuthal dependence of the depolarization should permit a determination of details of the noncentral interaction between a neutron and a proton.

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251 Small Angle Diffraction of Neutrons and Similar Wave Phenomena. Otto Halpern and Edward Gerjuoy. Phys. Rev. 76, 1117-29(1949) Oct. 15.
A study of the diffraction of waves under very small angles is presented; the diffraction objects are ideal microcrystals, crystallites, assemblies of polycrystals and amorphous bodies. The diffraction cross section was found to depend in a very sensitive way on the angle of scattering and on the nature and orientation of the scattering object. The most significant result found consisted in the observation that the integral cross section of the diffraction object is in general proportional not to the number Z of atoms contained in the scatterer but to a higher power ($Z^{4/3}$ or $Z^{7/6}$). The results are applied to the interpretation of a number of experiments on the small angle scattering of neutrons and of light waves; possible effects on the polarization of neutrons are also discussed.

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252 Instrumentation for a Nuclear Reactor (discussion). V. L. Parsegian. Nucleonics 5, 76-8(1949) Oct.
The instrumentation for a nuclear reactor is divided into three components, i.e., a detector element, a telemetering system, and an indicating or registering instrument. The problems in designing appropriate detector elements and telemetering systems are considered briefly.

253 Note on Shielding of Atomic Rockets. L. R. Shepherd. Brit. Interplanetary Soc. J. 8, 149-57(1949) July.
A discussion is given regarding shielding requirements on atomic rockets. It must protect the crew from radiation caused by the propulsion motor and also prevent dissipation of excess heat due to absorption of penetrating radiation in the uncooled regions of the rocket. The mechanism of γ-ray absorption is also described. The possibility of eliminating the shielding by using propellants with a high boiling point and a high latent heat is discussed. This is done by the use of a nuclear chemical step rocket.

254 Scientific and engineering problems of nuclear power [Lecture No. 1 of series held at Imperial College]. O. Buneman. AERE-T.L./30, Jan. 20, 1949. 8p.
World power consumption corresponds to nuclear combustion of 100 tons of fissile material p.a. Pre-war supplies of natural fissile material (U^{235}) were less than 10 t.p.a. In order to keep stocks of materials invested in nuclear power schemes down to realistic quantities, such stocks must yield about 1 Mw power per kg fissile material. This corresponds to 2-1/2 years turnover time. Breeding of artificial fissile substances probably requires extreme neutron economy ($n \sim 2$ or more). If successful, it would relieve nuclear fuel shortage.

255 Scientific and Engineering Problems of Nuclear Power [Lecture No. 2 of series held at Imperial College]. O. Buneman. AERE-T.L./31, Jan. 27, 1949. 7p.
Condition of criticality leads to furnaces small in weight in regard to fissile fuel, but immense in output. Fast neutron

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fission: 100 Mw or more from spherical volumes of the order of 1 ft diameter. Slow neutron fission (enriched or pure fissile materials): 10 Mw from 10 ft diameter. Slow neutron fission (natural U): Large structures. High density of fissile material required for small size. Moderators C, Be, BeO (also dense) seem to be the only possible choices. Slow neutron reactors limit severely the choice of additional materials, owing to neutron capture (σ_c). Natural U reactors ("piles") must have U in compact lumps or rods.

256 Scientific and Engineering Problems of Nuclear Power [Lecture No. 3 of series held at Imperial College]. AERE-T.L./32, Feb. 3, 1949. 6p.
Fissile fuel elements deteriorate by depletion, accumulation of fission products, and damage due to high speed charged particles. Their endurance under such treatment is unknown. Frequent re-conditioning involves a large amount of chemical and metallurgical work. Damage to fissile and other materials (moderator, carriers, structurals, protectives) is associated with high energy neutron flux which can be established only in reactors; it is closely linked to power rating (Mw per kg), but somewhat larger in fast neutron reactors. Metals are most likely to have long endurance. Damage to living tissue is so large that many feet of concrete have to surround each reactor. Convection of activity by discharge of used fissile elements or by coolants is potentially a great danger: if 1/100 ppm of weekly world output of fission products was "lost" and of this again 1/100 ppm found its way into a human body, this body would be safe only provided the activity was diluted throughout and did not become concentrated in a single organ as many fission products do. Coolant circuits must be closed.

257 Scientific and Engineering Problems of Nuclear Power: Heat Removal and Utilization [Lecture No. 4 of series held at Imperial College]. AERE-TL-32-(E)4, Feb. 10, 1949. 11p.
At the required rating, heat removal by forced convection depends critically on permissible maximum temperatures and dimensions of fuel elements, as well as on coolant properties and dimensions of coolant channels. Temperatures of fissile elements ought to exceed 300° appreciably. Ceramics and refractories are needed. Lumping is undesirable: coolant must have access to interior of reactor and reacting material. Gas coolants require rather high pressures and pumping powers; best gases for this purpose are H_2, He, CO_2. Liquids (Na, Bi) require heavy tubing which might be excessively expensive in neutrons, and the corrosion problem is more serious.

258 Scientific and Engineering Problems of Nuclear Power: Constructional Aspects of Reactors [Lecture No. 5 of series held at Imperial College]. J. Diamond. AERE-TL-32(E)5, Feb. 17, 1949. 9p.
The choice of materials is a matter of difficult compromise between engineering, nuclear, chemical, metallurgical, and economic requirements. Shielding and refuelling under safe conditions is a major engineering problem. Under anticipated temperature restrictions, power will in the first

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place be obtained by steam raising. Conversion of fission energy direct to electricity is not feasible; efficiencies must be high. Marine propulsion is an attractive special application. Circulating pumps and one side of heat exchangers will become active. Servicing in the conventional sense will be impossible.

259 Scientific and Engineering Problems of Nuclear Power: the Control of Nuclear Reactors [Lecture No. 6 of series held at Imperial College]. R. V. Moore. AERE-T.L.-32(E6), Feb. 24, 1949. 12p.

The control of reaction is a matter of controlling the neutron chain as well as heat flow. It is possible only because of delayed neutrons. Considerable electronic gear is required for "monitoring." An unstable equilibrium must be controlled. Criticality is so delicate that fluctuations of atmospheric temperature and pressure are sufficient to make a pile "run away," unless checked by adjustment of controls.

260 Scientific and Engineering Problems of Nuclear Power [Lecture No. 7 of series held at Imperial College]. O. Buneman. AERE-T.L./33, Mar. 3, 1949. 8p.

This is a summation paper for the six preceding lectures.

261 Some Elementary Observations on the Mode of Operation of the Uranium Pile. Ragnar Liljeblad. Arkiv Mat. Astron. Fysik 36 B, No. 1 (1948) 5p.

The problems of pile design are considered and an attempt is made to formulate definite alternatives for the design of a pile which will yield the maximum exchange of energy. It is shown mathematically that the following alternatives exist: (1) it is possible to use a pile design which permits the use of both U^{235} and U^{238} as energy sources, as the quantity of fissionable material will not diminish with time; (2) it is only possible to obtain a quantity of energy of the same order as that available from U^{235}; or (3) a third alternative which excludes the possibility of (1), e. g., extracting 5 to 10 times the amount of energy available in U^{235}. It is demonstrated that if alternative (3) should present itself, it would be equally possible to construct a pile operating according to the first method, in which case that would naturally be the one chosen. Or, on the other hand, should alternative (1) not be feasible, then alternative (3) cannot be realized either, and only the second alternative remains.

262 Apparatus for Particle Acceleration. F. A. Heyn. Nederland. Tijdsch. Natuurk. 15, 45-73(1949) Mar. (in Dutch).

Various types of high voltage generators are described and the theory of the motion of particles in alternating fields is summarized. The applications of this theory to linear accelerators, proton synchrotons, electron synchrotons, and betatrons are discussed. Some details of recent instruments are given.

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263 Betatron Injection into Synchrotrons. F. K. Goward. Proc. Phys. Soc. (London) 62A, 617-31(1949) Oct. 1.

The factors influencing the proportion of electrons which may be trapped and accelerated in a transition from betatron to synchrotron operation are noted; this transition is a vital factor influencing the design of the normal electron-synchrotron. Machines of various energies are studied, and it is shown that the important considerations in the design are quite different in different energy ranges. The theoretical predictions are compared with experimental evidence obtained on 14 and 70 Mev synchrotrons, and it is concluded that the agreement is sufficient to give confidence in the simplified theory.

264 Construction and Calibration of a Cylindrical Electrostatic Analyzer. S. K. Allison, S. P. Frankel, T. A. Hall, J. H. Montague, A. H. Morrish, and S. D. Warshaw. Rev. Sci. Instruments 20, 735-44(1949) Oct.

A cylindrical electrostatic deflector has been constructed with an average radius of 15 cm, spacing of 0.5 cm and deflection of 90°, in which the deflecting potential can be in the neighborhood of 50 kv. Thus protons up to 0.75-Mev energy can be focused. Movable slits have been incorporated in the design, and the geometry of the entrance and exit apertures of the deflecting channel is such that the stray field may be calculated analytically. This has been done for the case in which the deflecting plates are symmetrically charged above and below zero potential. The predictions have been compared with experiments on the focussing of electron beams by the instrument under controlled conditions. Agreement with the calculations is demonstrated within the accuracy of the experiments, which is about 0.3%. Experiments with asymmetric charging of the electrodes are reported and shown to agree with a plausible extension of the theory. Further experiments investigated the effect of small displacements of the slits from the computed focal positions. A set of factors, or calibration constants, has been measured so that, given the coordinates of the centers of the entrance and exit slits, and the potentials applied to the deflecting plates, the kinetic energy of the focused ion beam, as it left its source at zero potential, can be calculated to within 0.3%.

265 The Electron Cyclotron. W. J. Henderson and P. A. Redhead. Nucleonics 5, 60-7(1949) Oct. (See also NSA 2-241).

A small experimental model of the electron cyclotron or microtron, which was built at the National Research Council laboratories in Ottawa, Canada, is described. The electron cyclotron is distinguished from the synchrotron by the use of a constant magnetic field and applied radio frequency. This accelerator operates at energies up to 5 Mev and has the following advantages: (1) simplicity; (2) elimination of necessity for an electron injection system; (3) negligible radiation losses from the particles; and (4) the wide spacing between orbits facilitates extraction of the orbits. The disadvantages of the instrument are that (1) a solid magnet is required so that the cost of the machine varies approximately as the cube of the final energy, and (2) at high energies the

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first orbit will not clear the resonant cavity. The latter can be overcome by using slotted cavities.

266 Harmonic Synchrotron for Accelerating Protons. J. D. Lawson. Atomic Energy Research Establishment Report AERE-Memo-G/M-119, Feb. 1, 1949. 9p.

Protons cannot be accelerated in a conventional synchrotron because their velocity does not reach that of light until very high energies. It has been suggested, therefore, that the various harmonics of the rotating field in the synchrotron could be used in turn as the particle velocity increases. In this paper this suggestion is examined in some detail, and it is found that such a machine might be made, but is near the boundary of practicability. It has not been possible to discover without further analysis on which side of the boundary it lies. An appendix on the shape of guided waves with phase velocity less than that of light is included.

267 High-current Betatron Conditions. R. Latham and M. J. Pentz. Nature 164, 485-6(1949) Sept. 17 (Letter to the editor).

A simple theory has been developed which relates the flux φ, linking the stable orbit to H, the guiding magnetic field at the orbit, for the general case of a betatron in which the current of accelerated electrons is large. Expressions for φ as a function of H are given for small, intermediate, and large volumes of "n," the number of electrons per cm^3 which have initial velocities within the range of magnitude and direction in which capture into a stable orbit will be possible. In the analysis the effects of space charge are assumed to be negligible. This would be the case if the distribution of electron current density is uniform and the electrostatic field is circularly symmetrical over the cross section. It is noted that although this is necessary as a simplifying assumption, it is possible that the error introduced by this oversimplification may not be small.

268 A Modulator for a Cyclotron Ion Source. H. Whitby and M. Snowden. Atomic Energy Research Establishment Report AERE-G/R-307, Feb. 1949. 18p.

A pulse generator for supplying power to the ion source of a frequency modulated cyclotron is described. A mercury thyratron used in conjunction with suitable pulse forming networks gives the required output pulses. Pulse lengths from 5 to 100 μsec are selected by remote switching and a maximum output of 450 volts 50 amp can be delivered to the ion source. Impedance matching of the pulse forming network to the ion source is maintained for different gas pressures and filament temperatures by switching in shunt resistances. The modulator is normally triggered by 50-volt pulses obtained from the cyclotron frequency modulation system, but for checking purposes a built-in trigger circuit can be used. A small cathode-ray tube displays any of the various wave forms in the modulator and facilitates operation and servicing. A maximum repetition frequency of 400 cycles can be used. The whole equipment is housed in a single 6-ft rack and operates from a 230 volt, 50 cycle, single-phase supply. Circuit diagrams included.

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269 Stereoscopic X-ray Pictures with Betatron. Donald W. Kerst. (to U. S. Secretary of the Navy). U.S. Patent 2,473,956, June 21, 1949.

The objects of this invention are: to provide means by which the x-ray shadow formed by the passage of x-rays through the object under exposure can be greatly enlarged and still have well defined edges; and, to produce two simultaneous and powerful sources of x-rays by means of a single magnetic induction accelerator. The accelerator is disposed so that the rays which are produced cross and give two shadows simultaneously from separate sources. The apparatus is described in detail.

270 Relationship between the Intensity of the Spontaneous Luminescence of Some Crystalline Phosphors and the Intensity of the Absorbed Light. F. I. Vergunas. Izvest. Akad. Nauk S.S.S.R., Ser. Fiz. 13, 122-7 (1949)(in Russian).

The influence of temperature on the extinction of the spontaneous luminescence of ZnO, ZnS-Zn, and ZnS-Mn (blue zone) was studied; the following formula describes the relationships observed: $I = I_0/\left[1 + C\ \exp(-U/kT)\right]$, where I is the intensity of the spontaneous luminescence, I_0 the same at total excitation corresponding to the intensity of the absorbed light E, U a coefficient, C a coefficient growing with decreasing E. Another relationship is that between the intensity of luminescence I and that of the absorbed light E: it is linear for the three substances studied at temperatures corresponding to the zone of thermal saturation, while at temperatures lying within the zone of extinction I decreases faster than does E; this is expressed by the formula

$$I_i = E_i\left[1 + C\ \exp(-U/kT)\right]\Big/\left[1 + \frac{C}{E_i^m}\ \exp(-U/kT)\right],$$

where the subscript i denotes the case when the excitation is reduced i times, and m is a coefficient determined experimentally.

271 Atomic Energy and the Universe. J. Thibaud. Paris, Dunod, 1948. 318p.

The properties of atomic nuclei are reviewed in this non-technical text and nuclear energy and the atomic bomb are discussed. Also considered is the origin of the heat radiated by the stars and their evolution.

272 Atomistics and General Chemistry. R. Renault. Paris, Dunod, 1948. 426p.

The principles of modern physics are presented for the chemist. The first part of the book treats the following: relativity, kinetics of gases, theory of quanta, wave mechanics and radiation; the second part of the book is concerned with general chemistry and the properties of molecules.

273 Constructive Uses of Atomic Energy. S. C. Rothman, ed. New York, Harper, 1949. 258p.

This collection of articles and lectures by various authors deals with the peacetime, i.e., constructive, applications of nuclear energy. In non-technical language for the layman,

the applications of nuclear technology in the fields of industrial power, chemistry, metallurgy, aviation, ceramics, soil-fertilizer research, and biological, pharmaceutical, and medical research are considered. The following are given in three appendixes: (1) a chronological list of the highlights in the history of the development of nuclear energy: (2) a glossary of some of the important scientific terms of nuclear physics; and (3) a bibliography of 323 references which have been arranged in sections both according to subject and according to source-journal.

274 The Demonstration of Nuclear Magnetic Resonance. N. J. Hopkins. Am. J. Phys. 17, 518(1949) Nov. (Letter to the editor) (See also NSA 3-754).

A simple method of demonstrating proton magnetic resonance is described. The apparatus required for the demonstration includes a 4,000-oersted (minimum value) magnet having a gap width of 2 cm or more with pole pieces large enough to ensure homogeneity over a volume of the order of 1 cm^3 and a 300-v power supply, an oscilloscope, and a small regenerative detector and amplifier circuit. The construction details have been given elsewhere (Rev. Sci. Instruments 20, 401(1949)).

275 Matter, Electricity, Radiations. Marcel Boll. Paris, Bibliothèque des Chercheurs et Curieux, 1948. 128p. (in French).

The various phenomena of nuclear physics are discussed in a nonmathematical fashion. Among the topics treated are: (1) the elementary particles and (2) interactions between electromagnetic radiation and matter.

276 The National Academy of Sciences. Abstracts of Papers Presented at the 1949 Autumn Meeting, Rochester, New York. Science 110, 437-46(1949) Oct. 28.

Abstracts are given of the papers presented at the 1949 autumn meeting of the National Academy of Sciences in Rochester, New York. These include the following: On the possible existence of antinucleons, J. Ashkin, T. Auerback, and R. Marshak; Proton-proton scattering, C. L. Oxley; The heavy nuclei of the primary cosmic radiation, H. L. Bradt and B. Peters; Studies in diagnostic cinefluorography: familiar radiographic views as seen in slow motion, G. H. S. Ramsey, J. S. Watson, Jr., J. J. Thompson, F. Dreisinger, R. T. Weinberg, and S. Weinberg; Production and utilization of plasma proteins studied with radioactive lysine, Leon L. Miller; Hemoglobin synthesis and turnover in dogs measured with radioactive lysine, Charles L. Yuile; Problems in the experimental study of flash burns, Herman E. Pearse.

277 On the Origin of Elements. Maria G. Mayer and Edward Teller. Phys. Rev. 76, 1226-31(1949) Oct. 15.

The abundances of elements and of isotopes indicate that heavy and light elements have been produced by different processes. The origin of heavy elements is discussed in detail. It is assumed that the heavy elements were formed by a fission process from neutron-rich nuclear fluid. Simple assumptions are made about this fission process and isotopic abundances are calculated for $62 \leq Z \leq 78$. The properties of the neutron-rich liquid and possible details of the fission process are discussed.

278 Penetration of Atomic Particles through Matter. Niels Bohr. Copenhagen, Munksgaard, 1948. 114p.

A theoretical treatment of the following topics is given: the scattering of charged particles in atomic fields, penetration phenomena depending on nuclear collisions, atomic excitation and ionization in penetration phenomena, capture and loss of electrons in atomic collisions, and range-velocity relations. A three-page bibliography is included.

279 Spontaneous Decay Rate of Heavy Mesons. II. L. I. Schiff and D. L. Weisman. Phys. Rev. 76, 1266-7 (1949) Oct. 15 (Letter to the editor) (See also NSA 3-1242).

The previous investigation (Phys. Rev. 76, 303(1949)) has been extended and a new possibility is investigated, i.e., it is assumed that both π-e and N-e couplings exist, so that there is interference between first- and second-order processes in both π-e decay and nuclear β decay. The pertinent interaction terms in the Hamiltonian are given and an expression for the ratio of the rate of π-e decay to the rate of free neutron decay is obtained. From this the ratio $|\gamma/G|$ of π-e to π-N coupling constants is approximately equal to 1.3×10^{-7}, and it is noted that the magnitude of the π-μ-coupling constant required to explain π-μ decay as a pure first-order process is very nearly equal to the value of $|\gamma|$ obtained.

280 Theory of Atomic Nucleus and Nuclear Energy-Sources. G. Gamow and C. L. Critchfield. Oxford, Clarendon Press, 1949. 352p.

In this work on nuclear theory the following topics are considered: (1) the general properties of the atomic nucleus; (2) forces between nucleons; (3) theories of nuclear forces; (4) the general theory of nuclear structure; (5) the process of β transformation; (6) spontaneous disintegration of atomic nuclei; (7) electromagnetic radiation of nuclei; (8) nuclear collisions; (9) nuclear transformations; (10) thermo-nuclear reactions (from the standpoint of cosmology); and (11) nuclear chain reactions. The treatment of nuclear chain reactions is limited to a schematic discussion. New investigations in nuclear physics, which have appeared too late for inclusion in the body of the text, are treated briefly in appendixes.

281 The Absorption Method of the Determination of Beta and Gamma Energies. E. Bleuler and W. Zunti. Helv. Phys. Acta 19, 77-90(1946) (English translation in Naval Radiological Defense Laboratory Report AD-153(O)).

An improved method of evaluation of absorption measurement is given. The course of absorption curves for permitted β spectra is determined semi-empirically, and the energy of an unknown spectrum determined through comparison of its absorption curve with these normal curves. A review of the

literature shows the application of the method. Also, new values for a series of published disintegration energies are given. In a similar manner, the absorption curves of secondary electrons of γ rays may be evaluated for the purpose of the determination of quanta energy. The γ sensitivity of the counter is calculated approximately; the results agree well with the experimental values, whereas those of the formula of V. Droste (Z. Physik 100, 529(1936)) prove inadequate. 30 references.

282 Alpha-particle Detection with Dental X-ray Film. Carl C. Smith. Nucleonics 5, 72-3,92(1949) Sept.

Kodak type D. F.7 dental x-ray film packages were irradiated with polonium α particles from crystals of polonium nitrate of approximately 1.0 mc activity. By means of photographic plates information was obtained on the type of radiation induced, the energy of that radiation, and the values of the recorded photographic densities as related to the particle energies. The results obtained led to the following conclusions: (1) α-particle bombardment of the dental x-ray film cover material induces a β activity during α excitation. (2) The induced β activity is such that excitation of the film emulsion, even through a number of filters of metallic foil, is quite definite and produces reasonably high photographic densities with relatively low exposures. (3) The use of dental x-ray film to determine the energy of induced activities has only limited application, and definite limitations as to precision, but may serve in instances requiring only a rough approximation. It is noted that this type of film might be used to translate α radiation to β radiation to permit the counting of alphas when the Geiger tube walls are relatively thick.

283 Automatic Regulation of Wilson Chambers. R. Richard-Foy. J. phys. radium 9, 311-12(1948) Dec. (in French).

It is necessary to modify the regulation of a Wilson chamber when the temperature varies by increasing the expansion rate as the temperature increases. A method of making this regulation automatic is described which is a simple modification of a pressure regulator similar to the type used in the Radiation Laboratory at Berkeley.

284 Design of Grid Ionization Chambers. O. Bunemann, T. E. Cranshaw, and J. A. Harvey. Can. J. Research 27A, 191-206(1949) Sept.

Conformal representation theory is applied to a grid ionization chamber having plane parallel electrodes to give formulas useful in design. Expressions are obtained for the inefficiency of grid shielding of the electron collector, the spread of pulse size caused by the induced effect of positive ions, and the proportion of electrons collected by the grid. The theory was verified by experiment. The width of the polonium α-particle line at half-maximum was reduced to 50 kev or about 1% of the energy by the use of a suitable grid and operating voltages. The corresponding standard deviation from all causes was 22 kev, made up of 2 kev resulting from induced effect of positive ions, about 17 kev from noise in the amplifier, and 14 kev from straggling of ionization, thickness of source, and other effects. The spread caused by positive ions can, therefore, be almost completely eliminated by a grid.

285 An Electronic Instrument for Rapidly Tracing the Plateaux of G-M Counters. G. H. Vaze. Rev. Sci. Instruments 20, 746-7(1949) Oct. (Laboratory and shop note).

An electronic circuit is described which can be used to trace the voltage vs counting rate curve of a Geiger-Muller counter on an oscilloscope in a few seconds, whereas the usual method takes several minutes. The circuit essentially consists of a sweep circuit which varies the voltage on a Geiger-Muller counter linearly and appears as a horizontal sweep for the scope. The integrated counting rate appears as the vertical sweep, thus enabling the spot to trace the required curve. The name "platoscope" has been suggested for this instrument and "platogram" for the curves obtained. The latter are traced in a single sweep of 5 sec. Two typical platograms are shown.

286 Fast Pulse Amplifiers for Nuclear Research. W. C. Elmore. Nucleonics 5, 48-55(1949) Sept.

Some of the limitations affecting the speed of response of nonfeedback amplifiers are discussed. The factors affecting the amplifier rise time are treated and a nomograph is given for computing the rise time for unity gain. Characteristics of some of the tubes useful in pulse amplifier design are tabulated. The design of amplifiers whose speed of response approaches the theoretical limit is considered.

287 A Geiger Counter Spectrometer for the Measurement of Debye-Scherrer Line Shapes. W. H. Hall, U. W. Arndt, and R. A. Smith. Proc. Phys. Soc. (London) 62A, 631-8(1949) Oct. 1.

A spectrometer for the accurate measurement of x-ray powder diffraction line intensities and shapes is described. Monochromatic radiation is used, and the diffracted beam intensity is recorded by a Geiger counter. The intensity of the x-ray source is monitored continuously, and errors due to variations in its output are automatically compensated. The accuracy and resolution obtainable are demonstrated by some typical experimental results.

288 Geiger Counters for Soft X-Rays. Gösta Brogren. Arkiv Mat. Astron. Fysik 36 A, No. 18(1949). 10p.

Experiments have been made using soft x-ray Geiger-Mueller counters in which xenon replaced the customary argon filling. Although tubes filled with xenon and ethyl alcohol were unstable and had short plateaus, if ethyl ether or amyl acetate was substituted for the alcohol, good tubes were obtained which had long plateaus and which had a sensitivity approximately four times as great as that of the argon tubes. (In both cases the pressure of the rare gas was 100 mm of Hg and the counter was 10 cm long). It is noted that xenon tubes are more sensitive than those containing either argon or krypton, except in the 400-860 XU region, where krypton is to be preferred. Another means of increasing the sensitivity

of these tubes is the placing of the window in the middle of the tube so that the radiation enters the tube at right angles to the counter length. Tubes filled with tetramethyl-lead at 20 mm of Hg pressure have also been examined. The operation voltage is higher than in those filled with rare gases, but they have a very long plateau. By substituting tetramethyl-lead for the organic vapor added as an admixture in the rare-gas tubes, these can be improved considerably with regard to their sensitivity and their length of plateaus. Experimental tubes filled with argon (60 - 100 mm) and tetramethyl-lead (20 mm) proved to have excellent plateaus, but the operating voltage was considerably above that of common rare-gas tubes, although somewhat lower than that of the tubes of pure tetramethyl-lead. A Neher-Pickering type quenching circuit was used throughout the experiments described. A comparison has also been made with characteristic curves recorded using a Neher-Harper quenching circuit and it was found that if the grid voltage was held constant at about −5 v, characteristics were obtained having the same form and position in both cases. Data were obtained with various counters which indicated that the characteristic of a Geiger counter used with a Neher-Harper circuit is practically independent of the bias as long as it is varied within normal limits.

289 An Instrument for Energy Determination of β- and γ- Radiation. Kai Siegbahn and Hilding Slätis. Arkiv Mat. Astron. Fysik 36 A, No. 22 (1949). 24p.

A new instrument, the "limegraph," is described which consists of a toroid-shaped Geiger-Mueller counter which surrounds the pole pieces of an electromagnet. The inner side of the counter is made of thin Al foil in order to permit the electrons from the sample at the center of the limegraph to reach the counter. When the magnetic field is increased, the electrons are deflected, and at a certain field strength no electron can reach the counter. The upper energy limit of the electrons can be computed from the corresponding current in the electromagnet. This method is compared with other methods for measuring the upper limits of β spectra, especially that of Occhialini and Libby. Since the center of the limegraph is filled with the same gas mixture as the counters, some of the electrons are scattered. This phenomenon is reduced by the use of helium instead of argon. The scattering phenomenon produces a "tail" above the end of the limegraph curve. The intensity of the tail can be diagrammatically computed and the necessary correction made. The space angle of the registered electrons depends on the ratio between the radius of the curvature of the electron paths and the radius of the aluminum window of the toroid counter; the influence of this variable space angle is investigated. The transmission factor of the limegraph varies between 10 and 16%. By means of the Compton-effect the γ radiation can be measured. The limegraph curve in this case becomes an almost straight line, the intersection of which with the scattering background gives the γ energy when the calibration factor is known. The γ radiations from Hg^{203}, Cs^{134}, Fe^{59}, Zn^{65}, and Co^{60} were investigated. The computed energies are compared with the results other authors obtained using different methods. The scattering background at the upper limit of the β spectra, corresponding to the field current I_0, is constructed as a function of the intensity measured for $I_0/2$. In this way the upper energy limit of β spectra is obtained from the intersection of the limegraph curve with the scattering curve; the results are given for S^{35}, Co^{60}, Cs^{134}, and P^{32}. In cases where no internal conversion lines mask the distribution of the β particles at the upper end of the β spectrum (Cs^{134}), good agreement with the data of previous investigators is obtained. Some of the possible further applications of the limegraph are discussed.

290 On Luminescence Produced by α Rays. T. V. Timofeeva. Izvest. Akad. Nauk S.S.S.R., Ser. Fiz. 13, 135-9(1949) (in Russian).

Using various methods, the relationship was investigated between the intensity (brightness) of scintillations, produced in ZnS crystals by α rays, and the size of these crystals. In a screen made of crystals containing traces of Ra, the distribution of intensities I and the distribution of sizes r were measured, from which the preliminary relationship $I = kr^3$ was found. However, a certain maximum I was to be expected when a certain value of the crystal volume was reached. This was ascertained by a microscopical study of isolated crystals irradiated from the outside: beyond $r \sim 5\mu$, the law $I = kr^3$ changes into $I = kr^2$, which shows the preponderance of the effect of the fusion by the eye of two or more scintillations produced in one crystal. The amount of this effect was estimated by determining (1) the probabilities of the formation of multiple scintillations in crystals of different size, and (2) the time interval of visual-impression fusion: it was found that the transition towards the relationship $I = kr^2$ takes place when the probability of the formation of two scintillations in one crystal exceeds 0.1 of the total number. By using diaphragms in front of the α source, the multiple scintillations could be eliminated; by this method the final result was reached, giving $\sim 5\mu$ as the optimal size of ZnS crystals; since the mean energy of α particles employed is equivalent to a range in the crystal equal to 5.8μ, it is seen that the optimum size is correlated with the total loss of the particle's energy within the crystal. The efficiency of the process, i.e., the ratio between the luminescent and the absorbed energies, was found to be 1.0-2.5%.

291 New Application of Axial Magnetic Fields in β Spectrometry. Michel Georgesco. Compt. rend. 229, 297-9(1949) July 25 (in French).

Calculations are made which suggest the feasibility of a new type of β spectrograph which is especially suitable for the study of low-energy electrons. In a spectrograph of this type, the magnitude measured is the degree of rotation of the images rather than the usual measurement of the focal length. The advantages of this type of apparatus are discussed and it is noted that a model spectrograph of this type has been constructed. A description of the instrument will be published shortly.

292 A New Method of Measurement of the Curvatures and Scattering Deflections of Cloud Chamber Tracks. J. Rüling and H. Gheri. Experientia 4, 348-9(1948) Sept. (in German). (See also NSA 3-164).

The advantage of a differential plot of lateral displacements (along a curved cloud chamber track) as compared with a di-

rect plot, is noted. This work has been reported in greater detail in a more recent journal. (Acta Phys. Aust. 2, 335 (1949)).

293 Notes on the Use of the Scintillation Alpha Counter. A. A. Smales, L. Airey, J. Woodward, and D. Mapper. Atomic Energy Research Establishment Report AERE-C/R-306, Feb. 1949. 50p.

The use of the scintillation alpha counter as an analytical instrument has been investigated. Development work has been undertaken and experience of the use of several varieties of apparatus over the past nine months is recorded. The use of an aluminized nylon screen between the sample and phosphor is described, and the advantages discussed. The features associated with this type of counter which are of prime importance are the low background counting rate (< 0.5 c/m) and the large sample trays permissible. For general tracer work in which errors of up to 5% are not too serious, the most recent model appears satisfactory. For work of extreme sensitivity (e.g., biological investigations) where the background should be less than 0.1 c/m, only one suitable instrument has been produced.

294 On a Type of Counter Permitting the Absolute Measurement of the Number of Disintegrations Produced in a Radioactive β Source. René Cohen. Compt. rend. 229, 356-8(1949) Aug. 1 (in French).

A description is given of the construction of a self-quenching Geiger-Mueller counter suitable for absolute determinations of the number of disintegrations of β^+ and β^- emitters having half-lives greater than 5 min. The counter, which contains a mixture of argon and alcohol vapor, is accurate to within better than 3%.

295 On the Construction of Geiger Counters and Associated Electronic Circuits. M. A. Vigón and R. Segovia. Anales soc. espan. fis. y quim. 44, 686-9(1948) Nov.-Dec. (in Spanish).

Counters are described which have a Geiger range which extends from 100 v to about 1,000 v. Chemically deposited Hg on glass served as the cylinder and the central wire was of W. A purified dry air filling (4 to 5 cm of Hg), which contained alcohol for self-quenching, was used. Partially attributable to the photo-effect of Hg, the background count was about 30/min. The discharge duration was about 5×10^{-4} sec. A simple amplifier for earphone detection, for use in the field, is described, as well as integrating and recording circuits of a laboratory equipment incorporating a Neher-Harper extinction circuit. The instrument was designed for use when discrimination among particles is not necessary.

296 On the Disappearance of the Latent Image in the Photography of the Trajectories of α Particles. René Coppens. J. phys. radium 10, 11-13(1949) Jan. (in French).

The latent image of the trajectory of a charged particle disappears in a period of time which varies with the experimental conditions. The decrease in the number of trajectories visible as a function of the time has been investigated using a low-magnification (200-300) microscope; the curves obtained indicated a Gaussian distribution having a maximum at the most probable duration-time, T. The equation of the curves is of the form $n = K e^{-(t-T)^2/\rho^2}$ and each type of plate has a characteristic value of the ratio, T/ρ. The influence of the temperature and the humidity on T was also investigated and in both cases appreciable effects were observed. When the temperature was increased from 15-50°, for example, the value for T was found to decrease from 16 days to 10 hrs. Also, when the humidity was varied from normal to the saturation point, T was observed to drop from 16.5 days to about 5 days, in a typical case.

297 Photographic Emulsions in Nuclear Physics. Peter Meyer. Naturwissenschaften 35, 369-74(1949)(in German).

The role of photographic emulsions in nuclear physics is reviewed. The properties of such emulsions are discussed with special emphasis on their use for the detection of protons and α particles, and of uranium fission and cosmic ray particles. An extensive bibliography covers the period from 1910 to the early part of 1948. Over 100 references, 14 figures.

298 The Physical Basis of Crystal Counters. F. Stoeckmann. Naturwissenschaften 36, 82-6(1949)(in German).

A review is given of the literature concerning crystal counters used for the detection of β and γ rays. The physical basis of these counters is discussed, in particular photo-electric conduction in isolating crystals, and the amplication, in the crystal, of photo-electric currents. A typical circuit arrangement for a crystal counter is given. The resolving power and the counting efficiency for various radiations are discussed. Special attention is given to the properties of cadmium sulphide as a crystal counter. The bibliography covers the period from 1920 to the early part of 1948. 40 references, 6 figures.

299 On the Production of Anthracene Crystals for use in Scintillation Counters. A. D. McGuire. University of Rochester Technical Report No. 4 of the 130 in. Cyclotron (NR-025-017), nd. 4p. (NP-1124).

This discussion of methods of producing anthracene crystals states that excessive impurities in the starting material prevents crystals from growing to impressive size and also causes high optical density. The growing of commercially obtained anthracene into single crystals 2.5 in. in diameter and 4 in. long with a slight yellow discoloration is described. The most satisfactory technique reported for preparing the crystals for use involves cutting pieces of the desired dimensions from large crystals with a jeweler's saw, trimming the surfaces flat with a razor blade, and immersing the pieces in benzene for about 5 min. The above procedure has produced surfaces of an optical quality which produces good internal reflection. 10 references.

PHYSICS GENERAL

300 **The Rosenblum Spark Counter: A New Counter for the Detection of Fast Ionizing Particles.** Ronald M. Payne. J. Sci. Instruments 26, 321-4(1949) Oct.

An investigation has been made of the characteristics of the α-particle wire counter recently demonstrated by Rosenblum (Chang and Rosenblum, Phys Rev. 67, 222(1945)) and of the possibility of using it for the detection of less ionizing particles. A particle is recorded by the passage of a spark between a fine wire and a flat plate in close proximity, and between which a corona discharge exists in the open air. Counters of this type can be constructed with a plateau of about 2500 v in length by using higher voltages than those originally suggested by Rosenblum. The accidental rate is less than one in 4 hr and the dead time is about 10^{-4} sec. It is shown that the recording properties of the counter depend on the direction of the incident particles in passing through the sheath of corona discharge surrounding the wire. By using a wire-plate system, some objections to the earlier point-plate counter of Greinacher (Helv. Phys. Acta 9, 590(1936)) are eliminated. The result is an instrument of simplicity which might have advantages for many purposes. When the counter is working in an atmosphere of carbon dioxide or a 1% mixture of this gas with air, it is also capable of detecting protons and fast electrons. Such a development will greatly increase its field of application.

301 **Scintillation Counters.** W. H. Jordan and P. R. Bell. Nucleonics 5, 30-41(1949) Oct.

Recent work on the development of scintillation counters is reviewed. In particular, research on phosphors and on photomultiplier tubes for this type of application is discussed. Further possible applications of this type of counter are considered and it is noted that scintillation counters are most useful when one or more of the following properties are required: (1) high sensitivity to γ radiation; (2) short resolving time; and (3) a measurement of the energy of the particle or photon. It is suggested that with fast amplifiers and scalers, counting rates of a million/sec would be possible. 33 references.

302 **Self-quenching Geiger-Mueller Counters of Low "Effectiveness."** M. I. Daĭon. Doklady Akad. Nauk. S.S.S.R. 64, 305-8(1949)(in Russian).

The "effectiveness" of a counter is the probability "a" that it will record relativistic particles. The probability of recording particles, whose ionization is n times larger than that of relativistic particles, is na, (if $na \ll 1$). The probability of recording particles with the aid of a telescope of k counters, is $n^k a^k$. It is this last property that makes the low-effective counters convenient for the study of the strongly-ionizing components of the cosmic radiation. The author constructed such self-quenching low-effective counters, of 6.7, 10, and 20 mm diameter, filled with He + alcohol. Their effectiveness was measured by placing one such counter A and one ordinary counter B (100% effectiveness) within a two-group telescope C-D. The ratio between the triple coincidences CAD and CBD is the effectiveness of A. For three different combinations of partial pressures of the gases (details not given), the effectiveness was 76, 49, and 30%, the precision of the measurements being 5-3%. A theoretical formula is given, presenting the effectiveness as a function of the counter's diameter and of the number of ion pairs created along 1 cm within the counter at a given pressure.

PHYSICS GENERAL

303 **Sensitivity of Gamma-Ray Counters.** Gerald J. Hine. Science, 110, 380-2(1949) Oct. 7.

Various methods of increasing the sensitivity of γ-ray counters are described. The "end-on" use of Geiger-Mueller counters for this purpose is noted briefly and the results obtained for $CaWO_4$ crystal scintillation counters using a 1P21 photomultiplier tube are given. The latter are presented as curves of the counting rate as a function of the pulse height for sources of Co^{60}, Ra, and I^{131}. (Data are given both for an apparatus in which a Lucite rod is interposed between the crystal and 1P21 and an Al foil is placed over the crystal, and for an apparatus without the rod and foil.) The results obtained are in agreement with those previously reported by Moon (Phys. Rev. 73, 1210(1948)).

304 **Simple Apparatus for Control of Wilson Chamber Counters.** R. Richard-Foy. J. phys. radium 10, 19-21(1949) Jan. (in French).

A description and diagram are given of a simple apparatus for the control of a Wilson chamber. The set-up consists of twelve counters and controls the discharge of a thyratron for the expansion by means of a single 6J7 tube for the entire arrangement. It is possible to regulate the system so that the thyratron will light only for coincidences which are at least quadruple.

305 **Speed of operation of Geiger-Mueller Counters.** Hendrik den Hartog. Nucleonics 5, 33-47(1949) Sept.

Various investigations on the delays in the operation of Geiger-Mueller counters caused by the electron transit time, discharge development, discharge quenching, and deadtime, are reviewed. The dependence of the relative efficiencies of different counting circuits upon the counting rate is noted and some improvements in Geiger counters are described. 40 references.

306 **The Technique of the Double Photographic Emulsion in Nuclear Chemistry.** Edgard Picciotto. Compt. rend. 228, 2020-22(1949) June 27 (in French).

The method of double emulsions described here is free from several defects inherent in the usual method of impregnation of the photo-emulsion with solutions. A drop of the solution (about 5 mg) is placed upon the emulsion (generally 100 μ thick) of a plate, and allowed to dry; a sheet of "stripped" Ilford or Kodak emulsion is then firmly applied to the first one. The development is done at low temperature, low pH, and in the absence of CO_2; amidol proved satisfactory. The fixation, which takes place at 8-10°C in a diluted acid bath, must be slow (7-10 hr). For the counting the use of Cosyns' cartographic microscope is recommended. The limits of the drop are clearly visible, but can be made more contrasting by coloring the solution. The method can also be applied to suspensions, powders, and films.

PHYSICS GENERAL

307 Method and Apparatus for Detecting Radiations. Robert Earl Fearon (to Wells Surveys, Inc., Tulsa, Oklahoma). U.S. Patent 2,472,153, June 7, 1949.

This invention deals with the measurement of weak ionizing radiations, which is accomplished by subjecting a confined, moving and ionizable fluid to ionizing radiations (after proper de-ionization of the fluid); positively and negatively charged ions are produced in the fluid, and are separated into two groups by the means described; the current produced by the collection of one of the two groups of ions is measured and serves as an indication of the strength of the ionizing radiations.

308 Alpha Particle Counting. Casimer J. Borkowski (to Atomic Energy Commission). U.S. Patent 2,472,365, June 7, 1949.

An α-particle counting device is described which incorporates a high geometry (effective receptor surface) and a simple working mechanism for the easy determination of the degree of ionization in regions of the body, especially the hands. It contains an α-counting ionization chamber in which the high voltage electrode is the collecting electrode, and is in the form of a tube having an axially aligned rod which is connected to an amplifier.

309 The Use of Anthracene in Scintillation Counters. O. Huber, F. Humbel, H. Schneider, and R. Steffen. Helv. Phys. Acta 22, 418-20(1949) Aug. (in German).

The preparation is described of a pure anthracene crystal, 3 cm × 2 cm thick, to be used in scintillation counters. Synthetic anthracene, dissolved in a 1:1 mixture of benzene and benzol, is freed from traces of a coloring substance by chromatographic filtration through activated aluminum oxide. The recrystallized material is melted in a sealed pyrex ampule, previously evacuated and filled with 0.5 atm argon. A unique crystal, of good fluorescent properties, is obtained by the slow cooling (1°/hr) of the fused mass. The performance of such a crystal in a scintillation counter, by using a Co^{60} preparation (1.1 and 1.3 Mev), is described.

310 A Wide Range Radiation Instrument. Leonard Reiffel and Glenn Burgwald. Rev. Sci. Instruments 20, 711-15(1949) Oct.

A radiation monitoring instrument based on the scintillation counter is described which measures γ- (or β-) radioactivity levels from 1 mr/hr to 100 r/hr without changing scale. The instrument may thus be entirely unattended even in the vicinity of widely varying sources. The performance and limitations of the instrument are discussed, with means for increasing its ultimate sensitivity.

311 Diffuse Scattering of X-rays by Ice. P. G. Owston. Acta Cryst. 2, 222-8(1949) Aug.

The diffuse scattering of x-rays by single crystals of ice has been found to be of thermal origin. A few experiments were made using an improvised apparatus in which the crystal holder, mounted on a Mueller spectrometer, was cooled by a small bath of alcohol and solid CO_2. Most of the results described, however, were obtained using the low-temperature camera designed by Cox (Proc. Roy. Soc. (London) 135A, 49(1932)). The x-ray tube used was a modified Shearer-type cold-cathode (gas) tube, passing an apparent 14 ma at 45 kv potential supplied by an induction coil and Newman electrolytic interruptor. By polishing the cathode and anode of the tube after every 4-hr running, the emission intensity was kept at a maximum and the exposure times necessary with unfiltered radiation from a copper target were reduced to about 1 1/2 hr. Photographs were taken with the crystal stationary in as many different orientations as possible about each axis, at a temperature of about −5°C. A few exposures (time 4 hr) were also made using radiation made monochromatic by reflection from a crystal of urea nitrate. It is noted that the existing theory is inadequate to explain the observations, and needs extending to include the effects of vibrations of shorter wavelengths. The main features of the representation in reciprocal space of the diffuse scattering are discussed. It is found that the amplitudes of vibration of the molecules are of the order of 0.4 A at −5°C. The strong local disturbances which cause the diffuse streaks could include movements of the hydrogen atoms between neighboring oxygen atoms.

312 An Experimental Study of Back-Scatter with X-Ray Beams of Small Area. D. V. Mabbs. Brit. J. Radiology 22, 600-4(1949) Oct.

Measurements with a micro ionization chamber were made on the back-scatter produced by x-rays beams of less than 10 cm in diameter in the quality range of H. V. L. 0.06-1.4 mm Cu. A table of values for the back-scatter in a water phantom from these small beams is included. The values for the intermediate beam diameter of 10 cm are compared with those previously published, and the causes of discrepancy are discussed. The choice of material for the phantom and the possibility of a radiation cut-off produced by the stem of the measuring ionization chamber are sources of error in readings to be considered in determining the validity of measurements.

313 Radiation at Collisions of Fast Neutrons with Protons. I. Pomeranchuk and I. Shmushkevich. Doklady Akad. Nauk. S.S.S.R. 64, 499-502(1949)(in Russian).

Collisions between protons and neutrons, at high relative velocities, result in angular distributions of scattered neutrons which are essentially different in the case of ordinary interaction forces and in that of exchange forces. In the former case the scattering angles are very small, in the latter they are about equal 180°. Furthermore, the variation of the wave vector, and, consequently, of the velocity of the colliding particles, is considerably greater in the case of exchange forces; and since a greater variation in the proton's velocity means a greater variation of the derivative of the dipole moment during the time of the collision, the resulting radiation has a greater intensity. It seems probable that the cross section of the scattering with radiation should be considerably greater in the case of exchange forces than in that of ordinary interactions. The calculation confirms this conclusion. It appears, moreover, that this cross section must grow with the energy. The very energetic primary protons of the cosmic

rays, by colliding with the N and O atoms of the upper atmosphere, must produce an abnormally high number of photons that form, perhaps, the essential part of the soft component.

314 Reactive Correction for the Elastic Scattering of an Electron. S. Endo, T. Kinoshita, and Z. Koba. Progress Theoret. Phys. 3, 320-1(1948) July-Sept. (Letter to the editor).

The finite radiative corrections previously reported (Koba and Tomonaga, Progress Theoret. Phys. 2, 218(1947); Ito et al, Progress Theoret. Phys. 2, 216, 217(1947)) for the elastic scattering of an electron by a fixed electrostatic potential, which were obtained by the "self-consistent subtraction method" and on the basis of the C-meson theory, are considered with regard to the magnitude of their effect on the zero-th order cross section. The case of a slow electron is considered and both calculations are made. In both cases the absolute magnitudes of the finite corrections obtained are far below the limits of experimental detection; a marked difference between the two corrections is also noted.

315 The Single Scattering and Annihilation of Fast Positrons. Ho Zah-Wei and Walther Bothe. U.S. Office of Military Government for Germany FIAT Report No. 1132, May 29, 1947. 7p.

The preliminary results of an investigation into the cloud tracks of positrons are briefly reported. (1) Nearly head-on collisions between a positron and an electron were easily observed. During such collisions deviations from the theory occurred, probably because the magnetic interaction had not been considered adequately in the theory. (2) Three cases of the annihilation of a fast positron were observed. This corresponds to expectation according to the theory of H. A. Bethe. (3) During collisions of positrons and nuclei, the high losses of energy were much too frequent to be explained solely through the current theory of "Bremsstrahlung."

316 Slow Neutron Absorption Cross Sections of the Elements. M. Ross and J. S. Story. Atomic Energy Research Establishment Report AERE-T/R-295, Feb. 21, 1947. 25p.

Neutron absorption cross-sections from the unclassified literature are tabulated along with type of neutrons, method of measurement, remarks, and 83 references.

317 Small Angle Scattering of X-rays by a Dense System of Identical Particles. Gérard Fournet. Compt. rend. 228, 1421-3(1949) May 2 (in French).

It is noted that, when the particle density is high, interference between scattered waves cannot be neglected. In this case an expression for scattered intensity is used which is a generalization of the results of Zernicke and Prins (Z. Physik 41, 184(1927)) and Debye (Physik. Z. 28, 135(1927)) for liquids with spherical molecules. This expression involves the partition function of the system and the scattered intensity for individual particles. The latter quantity may be determined empirically from three measurements of scattered intensity

using different concentrations. Assuming the interaction between particles depends only on their separation, the partition function may be derived theoretically (Proc. Roy. Soc. (London) 188 A, 10; 190 A, 456; 191 A, 168). The final result is free of the objectionable features of Debye's expression.

318 The Analytic Behavior of Heisenberg's S Matrix. R. J. Eden. Proc. Roy. Soc. (London) 199 A, 256-71 (1949) Oct. 25 (See also NSA 1-1675).

The S matrix is considered for a system made up of an elementary particle being scattered on a fixed center which has internal excited states. At threshold energy values for inelastic scattering, the S matrix undergoes abrupt changes of behavior. A method of representing these as nonanalytic changes in the matrix elements as functions of the total energy is suggested, and some of the implications investigated. It is shown that it may still be possible for the eigenvalues of S to be analytic functions of energy at the threshold values. The usual perturbation theory of quantum mechanics is used to consider a resonance scattering system of this type, and it is shown that the nonanalytic changes in the matrix elements correspond to a nonanalytic change in the unitary condition of S. When the incident particle is a photon, the excited states of the scatterer are necessarily unstable, and the S-matrix elements have singularities in the complex energy plane which correspond to these unstable levels. These singular points show clearly the connection between the line widths for resonance scattering and Einstein's coefficients for spontaneous emission. It is shown that relative intensities of spectral lines may be obtained from the S matrix for scattering of light on an atom.

319 An Approximate Calculation of Energies and Coupling Indexes by the Method of Spin States. Claude Vroelant. Compt. rend. 228, 1029-31(1949) Mar. 21 (in French).

In the calculation of energies and coupling indexes by the method of spin states, it is necessary to solve a system of equations whose approximate solution is given elsewhere (Bull. Soc. Chim. France, 36-45(1949)). This article suggests two improvements in the approximate solution procedure. One is a matrix perturbation method, the other a series of successive approximations.

320 Calculation of Eigenfunctions and Eigenphases for a Continuous P-spectrum in the case of a Yukawa Potential. I. Hansson. Kgl. Fysiograf. Sällskap. Lund Förh. (No. 7) 178-95(1948).

The method of calculating scattering phases which Hulthen has used for S-states is applied to use with P-states. The variation is carried through for the central meson potential, for various trial functions with 1, 2, or 3 parameters, and a comparison made with the exact solution where possible, for a range of energy values. It is found that even with the simplest trial function, the phase values are accurate to 0.1% and the wave functions are usually correct to less than 1% of their greatest value over a large range.

PHYSICS GENERAL

321 The Concept of Motion in the Relativistic Quantum Theory. Ya. I. Frenkel. Doklady Akad. Nauk. S.S.S.R. 64, 507-9(1949) (in Russian).

The nonrelativistic mechanics, in its classical and quantum aspects, deals exclusively with the motion of unchangeable corpuscles or bodies. For the description of essentially different phenomena of creation, annihilation, and transmutation of corpuscles, a special mathematical apparatus of the relativistic quantum theory had to be set up. However, no attempt has as yet been done to generalize these methods and concepts, so as to include the ordinary motion. From this point of view, a particle's motion is the creation of the particle in one point and its annihilation in another. Thus, Schroedinger's "vibrating" electron must be replaced by the virtual appearance and annihilation of a pair, of energy $2mc^2$ and frequency $2mc^2/h$. In the case of photons, the description is limited to the phenomena of appearance and disappearance, (no tracks in the Wilson chamber, no wave functions in the configuration space). In the case of particles of nonzero rest mass, the corpuscular conception is replaced by that of the dynamical field, the true carrier of the mass, moment, spin, etc; the corpuscles are but coarse models of the quantum effects of the field. Thus, the sameness of elementary particles of one kind (e.g., electrons) is a relativistic quantization field effect, somewhat analogous to the nonrelativistic interpretation of the specific identity of nonelementary particles as due to a quantization of their relative motions. As to the nonelementary particles themselves, when considered from the relativistic point of view, they too become "elementary," i.e., material points with special properties (Frenkel, Zhur. Eksptl. i Teoret. Fiz. 16, 326(1946)). These new generalizations, by discarding the concept of trajectory, remove many of the difficulties in the field of the logic of causation, which have arisen with the introduction of the uncertainty principle.

322 The Different Types of Trajectories of Charged Particles in Inhomogeneous Magnetic Fields with Rotational Symmetry. Joseph Lafoucrière. Compt. rend. 229, 823-5(1949) Oct. 24 (in French).

The theory of trochoidal motion of β particles, given by Thibaud and Cartan (Compt. rend. 197, 447(1933); Nuovo cimento 197, 433(1938); Compt. rend. 197, 1604(1933)) is not valid for high energy betas because of the approximations used. A more general expression for the equation of the trajectory is given, and the shape of the orbit in special cases is discussed. It is mentioned that an unusual type of focusing effect is suggested by this expression, and will be described at a later date.

323 The e^4 Approximation of the Self-energy of the Electron Treated by Analytic Continuation. S. Bertil Nilsson. Arkiv Mat. Astron. Fysik 36 A, No. 5 (1948) 13p.

The calculation of the self-energy of the electron is carried out to the e^4th approximation by means of the analytic-continuation method of Pauli (Phys. Rev. 73, 903(1948)). If perturbation theory is also used, it is noted that although a finite value is obtained for the self-energy in the e^3 approximation (one-electron theory), the method fails for higher approximations due to the occurrence of logarithmic singularities. From a formal point of view this is somewhat of an improvement on the result given by the ordinary theory. A logarithmic divergence is preferable to a linear or quadratic divergence, since if a cut-off is made at some large momentum K it may still supply qualitative information. However, it is also noted that in the presence of a cut-off the specific effects of analytic continuation are lost; and for the method to be of any value, infinite upper limits to the momentum integrals are necessary. Thus, it is concluded that the use of analytic continuation in the form considered, even if it could be given a physical meaning, it is not capable of settling the divergence problems of present-day quantum electrodynamics.

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324 The Electromagnetic Shift of Energy Levels. O. Hara and T. Tokano. Progress Theoret. Phys. 3, 316-17 (1948) July-Sept. (Letter to the editor).

The relativistic calculation of the radiative correction of the energy for the Dirac electron has been made. Using perturbation methods the radiative correction is obtained up to the approximation of $e^2/\hbar c$. The divergence in the infrared region vanishes but a logarithmic divergence in the ultraviolet region does occur, contrary to Bethe's expectation. The latter divergence can be ignored if the electronic charge is renormalized suitably. When Pauli's approximation to the electron is applied (limiting the photon energy to less than mc^2) the expression obtained for the level shift is in agreement with that obtained by Bethe. When the C-meson theory is applied, the diverging term in the mass term vanishes under the condition $f^2 = 2e^2$, just as in the case of a free electron, thus showing that the C-meson is equally effective for the bound electron.

325 Exchange Phenomena of the Nucleons that Generate Penetrating Showers. H. A. Meyer and G. Schwachheim. Anais acad. brasil. cienc. 21, 199-203(1949) (See also NSA 3-1120).

It is noted that the exchange of charges between the nucleons in a proton-neutron scattering expected from the exchange-force hypothesis has been observed in cyclotron scattering experiments (Hadley et al, Phys. Rev. 73, 541(1948)); this would be expected to occur also in cosmic radiation, particularly in the penetrating shower-producing radiation which is believed to consist of protons and neutrons. Some recently reported experimental results obtained by Cocconi (Phys. Rev. 75, 6(1949)) on this type of cosmic radiation are discussed in a theoretical fashion from this standpoint. It is found that the transformation of protons into neutrons explains the whole of Cocconi's results. In addition it is noted that the aforementioned results cannot be explained on the basis of energy loss by ionization and that these experiments may be interpreted as an indication for the exchange character of nuclear forces at very high energies.

326 A General Theorem on the Transition Probabilities of a Quantized System with Spatial Degeneracy. Sybren R. de Groot and Hendrik A. Tolhoek. Compt. rend. 228, 1794-6(1949) June 8 (in French).

The authors outline a general proof for the following theorem: "The transition probabilities of a quantized system do

not depend on m_i if the Hamiltonian is invariant for spatial rotations," in which m_i is the Z component of angular momentum in the initial state. The summation rule of Ornstein and Burger (Condon and Shortley, The theory of atomic spectra. Cambridge, 1935. p. 238) is derived. It is noted that the proofs given in the paper are valid for forbidden transitions as well as permitted transitions, although this is not true of the usual proof. They are, therefore, of special value in the theory of β decay. The same subject will be treated in detail at a later date.

327 Magnetic Interaction between Neutrons and Electrons. H. Ekstein. Phys. Rev. 76, 1328-31(1949) Nov. 1.

The phenomenological interaction operator between neutrons and electrons is usually assumed to be $-\mu s \cdot B$. (μs=magnetic moment of the neutron, B=magnetic field of the electrons). Bloch has pointed out (Phys. Rev. 51, 994(1937)) that other operators are possible. It is shown that the class of operators considered by Bloch is equivalent to the form $-\mu s \cdot (H + 4\pi CM)$ where M is the spin momentum density of the electrons, $H = B - 4\pi M$ and C is an indeterminate constant. Diffraction by ferromagnetic crystals and magnetic double refraction are calculated for this interaction. Present experimental evidence excludes the value C = 0. Experimental methods for measuring C are discussed.

328 Mass of a Lorentz Electron. S. J. Barnett. Nature 164, 714(1949) Oct. 22. (letter to the editor).

Since Heaviside's demonstration of the mass of a Lorentz electron is not accepted by everyone, the author presents another demonstration involving momentum, rather than energy, considerations. The demonstration given has been used by Barnett for many years but has not been published to his knowledge.

329 Natural Philosophy of Cause and Chance. Max Born. London, Oxford University Press, 1949. 216p.

The material presented in this treatise on the philosophy of the natural sciences was previously given in a series of lectures at the College of St. Mary Magdalen, Oxford during 1948. Among the topics treated are the following: (1) casuality and determinism, (2) astronomy and particle mechanics, (3) mass, energy, and radiation, (4) electrons and quanta, and (5) quantum mechanics and indeterministic physics — metaphysical conclusions. Extensive appendixes contain brief mathematical discussions and derivations on particular topics relevant to the text.

330 New Remarks on the Interaction between an Electric Charge and the Electromagnetic Field. Louis de Broglie. Compt. rend. 229, 269-71(1949) July 25 (in French) (See also NSA 3-2356).

It is noted that in treating the interaction between an electric charge and an electromagnetic field, the point electric charge is replaced by an extended distribution, the density of which may be represented by a function of the Yukawa-potential type. This corresponds to the fact that the field of the particle is the superposition of a photonic field and a mesonic field; and, in order to separate the mesonic field, it is necessary to replace the point charge by the continuous distribution. This result has been obtained from the multitemporal theory: the author obtains it again from the wave-mechanical equations of the photon since this method is instructive. The results obtained indicate that the interaction between electric charges takes place with the simultaneous interference of a photon field and a mesonic field, relative to which the charges act in an equal but opposite fashion ($\epsilon_1 = -\epsilon$). In the case of several mesonic fields the sum ϵ_1 must equal $-\epsilon$. This relation, it is noted, should be of importance in the theory of nuclear forces. It is suggested that if it could be applied to neutral particles, it would confirm the fact that the sum of their mesonic charges is zero.

331 Nuclear Forces. L. Rosenfeld. New York, Interscience, 1948. 543p. (See also NSA 1-1444 and 2-1230).

This work has previously been published in two volumes. The first two parts correspond to the first volume, and the last two sections to the second volume. In Part I, the general features of nuclear forces are considered and the following topics treated: the properties of elementary particles, nuclear radii and mass-defects, and the charge dependence of nuclear forces. Two-nucleon systems (on the hypothesis of central interaction) are treated in Part II, and the following subjects are discussed: dynamical variables and fundamental equations, stationary states and physical properties of the proton-neutron system, central interaction between protons, and the charge independence of nuclear interactions. Part III on nuclear models and saturation properties (on the central force hypothesis) includes discussions on: a survey of nuclear models, nuclear multiplets, saturation properties of nuclear forces, properties of heavy nuclei, collective nuclear models, and properties of light nuclei. In Part IV, noncentral and nonstatic couplings are considered and the following topics are discussed: general properties of noncentral and nonstatic nuclear forces, noncentral couplings and two-nucleon systems, and noncentral couplings and properties of heavier nuclei. Useful information on allowed β transitions, the electro-magnetic properties of nuclei, and the strong-coupling theory of nuclear forces are given in appendixes. A five-page bibliography is also given.

332 On the Classical Theory of the Electron. Ryōyū Utiyama. Progress Theoret. Phys. 3, 219-28(1948) July - Sept.

The problem which was previously treated from the standpoint of the "many-time" theory (Progress Theoret. Phys. 3, 114(1948)) has been reformulated using one common time. Following a discussion of the limiting process, in which the electron is treated as a continuous field rather than as a point, the case of the point electron is considered. Using the Hamiltonian, the four-vector charge current expressions, and the Poisson bracket for the variables of the electrons, the equations of motion are obtained. From these the expressions for the interaction energy and the potential are obtained. The results obtained are similar to those previously formulated by Pauli and Dirac, i.e., a finite self-force is obtained, and for an electron at rest the self-energy becomes finite.

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333 On the Energy of the Mesonic Interaction of Particles. Jean-G. Valatin. Compt. rend. 228, 1573-5 (1949) May 16 (in French).

It is possible to depart from the analogy with the equations of the electromagnetic potentials in obtaining an expression for the energy of the mesonic interaction of nucleons. Correspondence reasoning leads to a relativistic formula of Møller for the mesonic case. The changes necessary for converting the expression for the neutral theory into that for the symmetric theory are noted. The formula of Møller used to obtain matrix elements for the interaction energy is equally applicable in the case of an antisymmetric, pseudovector, or scalar tensor source of the mesonic field. The matrix elements of the interaction energy can then be formed by making appropriate substitutions. Also, by introducing suitable variables for their isotopic spins, the corresponding expressions for the mesonic interaction energy of leptons or of leptons and nucleons can be obtained.

334 On the Infrared Catastrophe in the Problem of Electron Scattering. Takasi Sebe. Progress Theoret. Phys. 3, 304-11(1948) July-Sept.

Following a brief survey of Bethe and Oppenheimer's results (Proc. Roy. Soc. 70, 451(1946)) in their treatment of the "infrared catastrophe," a method which includes virtual processes in a rational form is developed in which only the non-relativistic calculations are made. (Heitler's radiation damping theory (Proc. Cambridge Phil. Soc. 37, 291(1941)) contains no virtual processes and hence the scattering cross section diverges in the region of lower frequencies). The author considers the system of "electron + radiation field" and calculates the wave functions of the stationary state for the system by the perturbation method up to the order "e." Following this, the fixed potential field V(r) can induce transitions between these perturbed stationary states; these processes now are easily calculable by the integral equation method which was originally developed by Heitler and Wilson. The resulting integral equations are found to be just the "modified Heitler equations" in which the virtual processes are now included.

335 On Integrals of Motion of the Center of Inertia of a System of Finite Masses, in the General Relativity Theory. I. G. Fikhtengolts. Doklady Akad. Nauk. S.S.S.R. 64, 325-7(1949)(in Russian).

Fok (Doklady Akad. Nauk. S.S.S.R. 32, 28(1941)) has derived integrals describing the motion of the center of inertia of a system of two finite masses, in the framework of the general relativity theory. In the present paper these expressions are generalized for any number of finite masses.

336 On the Interaction of Neutrons with Electrons. Bengt Holmberg. Arkiv Mat. Astron. Fysik 36 A, No. 6 (1948) 15p.

The experimental indications of the existence of a nonmagnetic type of interaction between neutrons and electrons is noted (Havens et al, Phys. Rev. 72, 634(1947); Fermi and Marshall, Phys. Rev. 72, 1139(1947)) and a more detailed estimate of the N-e interaction of lowest order is considered

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for a charged meson field. An expression for the static interaction between a neutron and an electron is given which was obtained using pseudoscalar meson theory. A certain constant b, which gives a measure of the interaction, has been calculated for various values of the other constants involved. An order of magnitude is obtained which is comparable with the value of $b=-1.8\times10^{-45}$ erg cm^3 estimated by Fermi and Marshall. Values of b are also given for Hulthén's nonsymmetrical scalar-pseudoscalar theory. (Arkiv Mat. Astron. Fysik 30 A, No. 9(1943)).

337 On the Production of Mesons in the Multiple Processes. W. Heisenberg. Z. Physik 126, 569-82(1949) (in German).

The assumption that by means of a nonlinear interaction during the collision of two energetic nucleons many mesons can be produced in a single act, leads to certain predictions concerning the properties of these meson showers. The observations of Powell and his collaborators with the new sensitive plates show the creation of many mesons in a single act. The consequences of the theory mentioned above are brought in such a form, that they can be compared with the new experiments. Furthermore, the reasons are discussed, which, in the view of the author, are in favor of the application of the non-linear theory, and against the point of view previously proposed by Heitler.

338 On Realistic Field Theories and the Polarization of the Vacuum. David Feldman. Phys. Rev. 76, 1369-75 (1949) Nov. 1.

The formal prescription for the regularization of divergent expressions in quantum electrodynamics which has been recently suggested by Pauli (Pauli and Villars, Revs. Modern Phys. 21, 434(1949)) implies very strongly that these same divergences may be similarly canceled in a realistic theory wherein one has a mixture of fields in the manner of Pais (Verh. Kon. Ac. Amsterdam 19, (1947)) and Sakata (Progress Theoret. Phys. 2, 145(1947)). Indeed, it may be readily seen that the Pauli regulator scheme corresponds field-theoretically to a family of spinor fields interacting with a family of neutral vector meson fields; the formalism is mathematically consistent (at least to the second order in the coupling constants) but physically unsound owing to the appearance of imaginary coupling constants. An attempt to remedy this defect by considering the most general mixture which is possible within the framework of ordinary field theory also leads to failure. Specifically, the current density which is induced in the vacuum by an external electromagnetic field is calculated to order e^2 for a variety of situations, but it turns out that no combination of charged scalar, spinor, and vector fields, with or without anomalous magnetic moments, leads to a full compensation of the divergences although the photon self-energy by itself may be made to vanish. It is concluded that, although the notion of a realistic approach to the theory of elementary particles remains an attractive one, the usual linear field theories do not in themselves seem to be adequate for this purpose; there is also always the possibility that it is the perturbation theory which is at fault.

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339 On the Renormalization of Mass and Some Aspects of the Theory of Radiation. Philippe Meyer. Compt. rend. 228, 1480-2(1949) May 9 (in French).

It is noted that both Bethe's nonrelativistic treatment of the displacement of the energy levels of hydrogen (Phys. Rev. 72, 241(1947)), and Schwinger's relativistic treatment of the problem of the interaction of radiation and matter (Phys. Rev. 73, 416(1948); 74, 1439(1948); 75, 651(1949)) are based on the following fundamental hypothesis: the characteristic energy of the electron, although infinite at the present stage of the theory, acts as an electromagnetic mass which is already included in the experimental mass of the electron. The method by which this hypothesis can be applied in the nonrelativistic case is examined. The Schroedinger equation for the system "electron+radiation" is considered. Using an appropriate interaction representation and a unitary transformation similar to that used by Schwinger, an expression for the infinite electromagnetic energy of the electron, which Bethe used to renormalize the experimental electron mass, is obtained. An expression for the equation of motion in terms of the experimental mass is then formulated which is similar to that obtained by Pauli and Fierz (Nuovo cimento 15, 167(1938)). The application of the Hamiltonian of the latter is justified by applying it to two cases, i.e., the photoelectric effect and bremsstrahlung, in which good agreement is obtained using the mass correction described.

340 On the Spin-Spin Interaction. P. Leal Ferreira. Anais acad. brasil. cienc. 21, 181-90(1949)(in Portuguese).

It is shown that Fermi's hyperfine-structure formula can be considered as an application of Møller's formula to s-states. The interaction "electron-positron," in nonrelativistic approximation is equivalent to a superposition of electric and magnetic dipoles. Finally, it can be shown that the Møller-Rosenfeld mixture of nuclear forces corresponds closely, in the case of a meson field, to the electromagnetic interaction between electron and positron.

341 On the Theory of the Subtractive Field. Louis de Broglie. Compt. rend. 229, 401-4(1949) Aug. 8 (in French).

It is noted that in two recent papers (Compt. rend. 229, 157 and 269(1949)) the author has developed a theory for the interaction between a charged particle and electromagnetic field which introduces in a new form the hypothesis of the "subtractive field" previously considered by Stueckelberg, Bopp, and Pais, and generalized by Feynmann. It is shown that this presentation of the hypothesis no longer raises the fundamental objection which it seemed to encounter heretofore. Formerly, if there were two fields interacting with the charged particle, certain difficulties were encountered if the subtractive field hypothesis was used. However, in the new form of the subtractive field hypothesis, which involves a reinterpretation of certain terms in the Maxwellian equations, the difficulty is removed.

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342 On the Unification of the Representations of the theory of a Particle of Maximum Spin 2(h/2). G. Pétiau. Cahiers phys., No. 33, 1-16(1948) Oct. (in French).

The general equations of particles of high spin obtained by combining the Dirac equations can be unified by the introduction of a 5th co-ordinate x_5 with suitable extra terms in the Hamiltonian. Equations for a particle of maximum spin 1, or of maximum spin 1/2, are obtained by the reduction of the equations in four dimensions. This unification can also be achieved by introducing a fifth co-ordinate canonically conjugate to the mass. The latter results also in new limitations on the interaction constants between particles of maximum spin 1 and those of maximum spin 1/2.

343 On the Use of Subtraction Fields and the Lifetimes of Some Types of Meson Decay. J. Steinberger. Phys. Rev. 76, 1180-6(1949) Oct. 15.

The method of subtraction fields in current meson perturbation theory is described, and it is shown that it leads to finite results in all processes. The method is, however, not without ambiguities and these are stated. It is then applied to the following problems in meson decay: (1) decay of a neutral meson into (a) two and three γ rays, (b) into a positron-electron pair, and (c) into another neutral meson and proton; (2) decay of a charged meson into (a) another charged meson and (b) a photon, and (c) into an electron (or μ meson) and neutrino. The lifetimes are tabulated. The results are quite different from those of previous calculations, in all those cases in which divergent and conditionally convergent integrals occur before subtraction, but identical whenever divergences are absent. The results are discussed in the light of recent experimental evidence.

344 On the Wave Equations of the Theory of the Particle of Spin $h/2\pi$ and their Generalizations. Gérard Petiau. J. phys. radium 10, 215-24(1949) June (in French)(See also NSA 2-444 and 2-826).

The various generalizations of the wave equations for a particle of spin $h/2\pi$ obtained by the de Broglie fusion method are examined and discussed. It is shown that the extension of this method to the case of close coupling between two particles of spin $h/4\pi$ of different characteristic masses leads to a representation of a particle of spin $h/2\pi$ which may be considered as possessing several characteristic mass states. The theory presented permits the confirmation and interpretation of the theories proposed by various authors both for the representation of the meson and in order to provide a basis for generalized electrodynamics.

345 Perturbation Methods for Dirac Radial Equations. G. Breit and G. E. Brown. Phys. Rev. 76, 1307-10 (1949) Nov. 1.

Two methods of calculating perturbation effects for the Dirac electron equation are discussed. The two radial functions enter symmetrically in the main contributions to the effects

calculated. The first method is related to the method of the Riccati equation for ordinary second-order differential equations but differs from it through the use of the ratio of the two radial functions rather than that of the logarithmic derivative of one of them. The second method has some similarity to Milne's phase amplitude method (Phys. Rev. 35, 863(1930)). The methods described have been helpful in two preceding papers (Breit et al, Phys. Rev. 76, 1299(1949) and Brown and Arfken, Phys. Rev. 76, 1305(1949)).

346 The Problem of Vacuum Polarization. H. Umezawa, J. Yukawa, and E. Yamada. Progress Theoret. Phys. 3, 317-18(1948) July-Sept. (Letter to the editor).

The recently developed neutral scalar meson field (C-meson field) which has been used for the cohesive force field of an electron (Sakata, Progress Theoret. Phys. 2, 145(1947)) is applied to the divergence problem of vacuum polarization, and the interaction between charged particles and photons is considered. It is noted that the self-energy of the photon becomes finite if it is assumed that Fermi particles and scalar (or pseudoscalar) mesons exist with a relative abundance of 1:2 in nature. Conversely the self-energy of the C-meson due to scalar (or pseudoscalar) mesons has been calculated and found to diverge quadratically, as in the case of photons. Similar considerations are applied to the fourth order perturbation calculation of the Compton effect.

347 Quantum Mechanics of Canonical Field Variables. R. Cade. Nature 164, 713-14(1949) Oct. 22 (Letter to the editor).

It is noted that with the assumption that space is quantized according to the recent theory of Snyder (Phys. Rev. 71, 38 (1947)) and Flint (Phys. Rev. 74, 209(1948); Nature 163, 131 (1949)), the Fourier resolution of the vacuum electromagnetic field is not valid. It is shown that a theory of canonical field variables analogous to that of quantized space leads to a "cut-off" frequency, the existence of which has previously been postulated on a purely ad hoc basis for dealing with the divergence difficulty of quantum electrodynamics.

348 Quantum Electrodynamics. III. The Electromagnetic Properties of the Electron — Radiative Corrections to Scattering. Julian Schwinger. Phys. Rev. 76, 790-817(1949) Sept. 15. (See also NSA 2-271, 2-1653).

The induction of current in a vacuum by an electron, which is a dynamical system and an entity indistinguishable from the particles associated with vacuum fluctuations, is considered. The additional current thus attributed to an electron implies an alteration in its electromagnetic properties which will be revealed by scattering in a Coulomb field and by energy level displacements. The second-order corrections to the current operator and the application to electron scattering are computed. Following a canonical transformation which effectively renormalizes the electron mass, the correction to the current operator produced by the coupling with the electromagnetic field is developed in a power series, of which first- and second-order terms are retained. Thus, second-order modifications in the current operator are obtained which are of the same general nature as the previously treated vacuum polarization current, save for a contribution that has the form of a dipole current. The latter implies a fractional increase of $\alpha/(2\pi)$ in the spin magnetic moment of the electron. The only flaw in the second-order current correction is a logarithmic divergence attributable to an infrared catastrophe. It is remarked that, in the presence of an external field, the first-order current correction will introduce a compensating divergence. Thus, the second-order corrections to particle electromagnetic properties cannot be completely stated without regard for the manner of exhibiting them by an external field. Accordingly, in the second section the interaction of three systems, i.e., the matter field, the electromagnetic field, and a given current distribution, is considered. It is shown that this situation can be described in terms of an external potential coupled to the current operator, as modified by the interaction with the vacuum electromagnetic field. Application is made to the scattering of an electron by an external field, in which the latter is regarded as a small perturbation. It is found convenient to calculate the total rate at which collisions occur and then identify the cross sections for individual events. The correction to the cross section for radiationless scattering is determined by the second-order correction to the current operator, while scattering that is accompanied by single quantum emission is a consequence of the first-order current correction. The final object of calculation is the differential cross section for scattering through a given angle with a prescribed maximum energy loss, which is completely free of divergencies. Detailed evaluations are given in two situations, the essentially elastic scattering of an electron, in which only a small fraction of the kinetic energy is radiated, and the scattering of a slowly moving electron with unrestricted energy loss. The appendix is devoted to an alternative treatment of the polarization of the vacuum by an external field. The conditions imposed on the induced current by the charge conservation and gauge invariance requirements are examined. It is found that the fulfillment of these formal properties requires the vanishing of an integral that is not absolutely convergent, but naturally vanishes for reasons of symmetry. This null integral is then used to simplify the expression for the induced current in such a manner that direct calculation yields a gauge invariant result. The induced current contains a logarithmically divergent multiple of the external current, which implies that a non-vanishing total charge, proportional to the external charge, is induced in the vacuum. The apparent contradiction with charge conservation is resolved by showing that a compensating charge escapes to infinity. Finally, the expression for the electromagnetic mass of the electron is treated with the methods developed in this paper. Radiative corrections to energy levels will be treated in a subsequent paper.

349 Radiative Corrections to Nuclear Forces in the Pseudoscalar Meson Theory. K. M. Watson and J. V. Lepore. Phys. Rev. 76, 1157-63(1949) Oct. 15.

The fourth-order corrections to nuclear forces in the charged and symmetrical pseudoscalar meson theories are obtained by the Feynman-Dyson method. All infinite parts are reconciled in terms of renormalization of mesonic and nu-

cleonic mass and charge. The potentials obtained by a non-relativistic approximation yield ordinary spin independent forces which behave as $1/r^3$ in the nonrelativistic region. This singularity is reduced to $1/r$ by relativistic effects. The potentials are in disagreement with experiment but the neutron-proton scattering problem is treated in order to obtain insight into the nature of relativistic corrections at 90 Mev, and it is shown that they are not small.

350 The Relation between Classical and Wave Mechanics. Robert Faure. J. Math. Pure et App. 28, 193-285 (1949) July-Sept. (in French).

The article consists of two parts. The first is a study of the relation between the first integrals of the equations of motion in classical and wave mechanics. In the second part the operators of wave mechanics are deduced from the condition of Hermiticity and from the relation between the classical and wave mechanical Poisson brackets. The author concludes that these conditions are sufficient to determine the Hermitian operators when the tensor capacity of the configuration space of the system is given.

351 Second Order Deflection-Focusing of Charged Particles in Homogeneous Magnetic Fields. H. Hintenberger. Z. Naturforsch. 3a, 669-70(1948) Dec. (in German).

The equation, which must be satisfied in order to obtain accurate focusing, is given; it involves the radii of curvature of the boundaries of a uniform magnetic field at the points of intersection by the principal ray and is a generalization of the formulas of Hintenberger. The derivation and discussion of the applications will appear later.

352 The S-Matrix for Meson-Nucleon Interactions. P. T. Matthews. Phys. Rev. 76, 1254-5(1949) Oct. 15 (Letter to the editor).

It is shown that in the single case of the neutral vector meson vector-interaction the differentials do not contribute to the matrix elements and a finite S matrix can be obtained by Dyson's method (Phys. Rev. 75, 486(1949)). It is noted that

a similar treatment is not possible for the pseudo-vector meson because the corresponding transformation does not remove the subsidiary pseudo-scalar field, but introduces a complicated interaction involving the subsidiary field in the power of an exponential (Dyson, Phys. Rev. 73, 929(1948)). A more detailed discussion of the derivation outlined and of the failure of Dyson's method in other cases will be published elsewhere.

353 Two Lectures. I. The Present Situation in the Theory of Elementary Particles. II. The Electron Theory of Superconductivity. W. Heisenberg. Cambridge, University Press, 1949. 52p.

The material in this text was previously presented in lectures at the Cavendish Laboratory in December, 1947. The first lecture deals with the present status of nuclear theory. Divergences in meson theory and in nuclear physics are explained as a natural consequence of present-day "correspondence theory." It is noted that it is only in quantum electrodynamics that a clear separation of the divergent terms leaves open a wide field of applications of standard quantum-theoretical methods. In the second lecture, quantum mechanics is applied to the theory of superconductivity. 35 references.

354 Wave Mechanical Equations of the Electron. Florent Bureau. Acad. roy. Belg. 35, 104-42(1949)(in French) (See also NSA 3-477).

By means of a change in variables in the Dirac equations of the electron the author brings the Dirac equations into a form similar to the Maxwell field equations. It is shown, by means of a general argument, that both equations indicate wavelike propogation. It is then assumed that some phenomenon is described by a vector u which satisfies a linear partial differential equation. Making some general assumptions about the nature of the solutions, and assuming the Lorentz invariance of the equation, the author arrives at the Dirac equation in terms of a new variable. Finally, the author derives the wave equation of the photon using the notation and methods previously introduced in the article.